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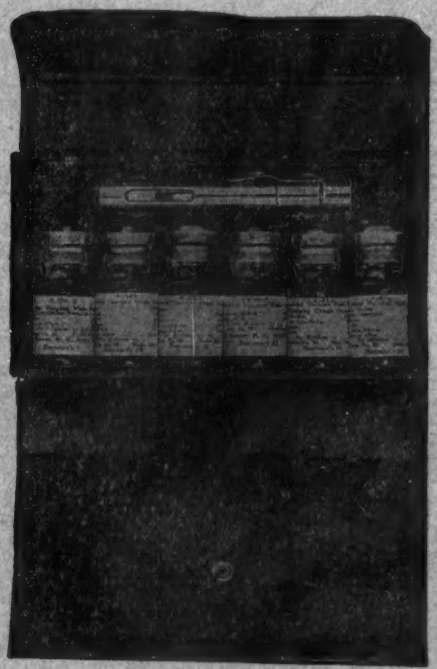

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SURGERY, GYNECOLOGY AND OBSTETRICS

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THE RELATION OF THE ISLETS OF LANGERHANS TO DIABETES WITH SPECIAL REFERENCE TO CASES OF PANCREATIC LITHIASIS

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ANY reference to the pancreas as secreting a hormone necessary for the utilization of sugar by the tissues of the body is misleading, as that function is, accurately speaking, exercised by only a very small portion of the organ, the so-called "islets" of Langerhans; so that what is generally understood as the relation of the pancreas to diabetes is rather the relation of the islets to that disease. And yet it should not be overlooked that in spite of a great abundance of proof from experimental and clinical studies, it has not been universally accepted that the deficiency of either the pancreas as a whole or of the specific portion of it, the islets, results in diabetes mellitus.

The purpose of this paper is to present examples of typical changes in the islets found in cases of true diabetes together with a detailed study of the histopathology found in a case of pancreatic lithiasis with special reference to the islets, and to correlate these findings with those recorded in the literature as obtained in experimental ligation of the ducts in animals. Such a combined study of clinical and experimental cases is of special advantage because of the similarity between the spontaneous and the induced conditions.

Pancreatic lithiasis is a very rare condition. Only a relatively small number of cases have been recorded in the literature, although Graaf speaks of it as early as 1667, and Morgagni and Cawley recognized the condition in 1765 and 1778 respectively. Opie (35) found two cases in 1,500 autopsies. Rindfleisch (39) found 3 cases in a series of 2,000 autopsies. Zesas (45) in 1903 collected only about 70 cases from the literature. Of these, 7 had been diagnosed clinically. Einhorn (10) states that the clinical recognition of this disease is exceedingly rare; much rarer than the very rare condition itself. In our own laboratory, this was the first case found in a series of several thousand autopsies.

Gall-stones are generally found in the gall-bladder; they are rare in the ducts. Pancreatic stones, on the other hand, are found lodging in the ducts in the absence of a cystic diverticulum. It is probable that pancreatic lithiasis is more common than is suspected, but the condition is not recognized unless the stones are large enough to meet resistance. Small stones may be expelled into the intestine without any symptoms. A few large stones have also been found in the fæces (13), but this is very much rarer than in the case of gall-stones.

In contrast to the relative frequency of gall-stones in the female, more than 75 per cent of cases of pancreatic lithiasis occur in the male. Lazarus (25) collected 57 cases from the literature of which 47 occurred in the male. He states that about 60 per cent are found during the fourth decade.

The stones may be single or multiple. When multiple they are usually small and often resemble sand. Moynihan (33) states that as many as 300 stones have been found. These may be present in the small branches of the main duct. The larger ones are usually found in Wirsung's duct. Some measure 4 centimeters in diameter. Ruth (40) removed one at operation weighing 280 grams. The stones are generally firm and white or grayish white in color. Chemically, they are composed principally of calcium carbonate with a mixture of phosphates and cholesterin. A few stones contain also magnesium carbonate and calcium oxalate.

HISTOLOGY OF PANCREAS

A brief description of the histology of the pancreas will be helpful to a better understanding of certain of the pathological changes to be treated in this paper.

Like the liver, the pancreas originates as a diverticulum of the intestine. It communicates with that organ by means of the Wirsungian duct. The secretory part of the pancreas is composed of a branched alveolar gland whose walls are lined by irregularly triangular epithelial cells. The appearance of these cells varies with the functional state of the gland (4). The alveoli empty into the intermediate tubules which pass over into the intralobular ducts. These ducts merge into the excretory ducts which in turn empty into the pancreatic duct.

Within the lobules of the organ, lying between the acini, are groups of cells differing markedly from those of the ordinary glandular tissue. They were first described by Langerhans (24) in 1869 and have since been known as the islets of Langerhans. These groups, usually round, are composed of small irregular polygonal cells containing round or oval vesicular nuclei in which one or more nucleoli are present. Kuehne and Lea (23), from a study of injected specimens, demonstrated tortuous capillaries as the vascular supply of these islets. The cells are smaller than the secretory cells, are slightly granular, and are arranged in the form of anastomosing columns or trabeculæ surrounding the relatively large tortuous capillaries with which they are in very intimate relation. Lane (26) has demonstrated that there are two distinct types of cells in the islets which differ in staining reactions after proper fixation. The islet cells also differentiate themselves from the acinic cells. Dogiel (8) using Golgi's stain was able to prove the absence of ducts in the islets. Kuehne and Lea (23) on injecting the ducts found that the material had not penetrated into the islets. Opie (35) concludes that, although the islets have the same origin as the glandular acini, they are structures which are independent of the secreting apparatus. Prolonged stimulation of the gland does not transform groups of acinic cells into islets as was believed by Lewaschew (27). The conclusions of this author, that islets are temporarily exhausted acini which resume their acinic form after a period of rest, have not been corroborated by other investigators.

According to Opie (35) the islets are about 3½ times as numerous in the tail or splenic portion of the organ as elsewhere. Their sizes range from 75 to 175 micra in diameter, although very large ones measuring 500 micra have been described. They are surrounded by fine connective-tissue capsules and, in general, show a resemblance to the glomeruli of the kidney in size, shape, and somewhat in structure. A marked difference, however, is noticeable in the lack of communication with excretory ducts; instead, they are in intimate relation with the lymphatics.

REVIEW OF THE LITERATURE

Experimental ligation of ducts. The study of this rather complex organ in its relation to diabetes has led to extensive experimental work. Arnozan and Vaillard (2) ligated the pancreatic ducts in rabbits and found that within 24 hours the ducts became dilated, the epithelial cells were desquamated, and there were protoplasmic changes in the acinic cells. At the seventh day there was beginning round cell infiltration, and at the fourteenth day a great deal of the parenchyma had been replaced by connective tissue. The authors thought that the sclerosis was due to the retained secretion. Ssobolew (44) ligated the ducts in rabbits, cats, and dogs. He found a

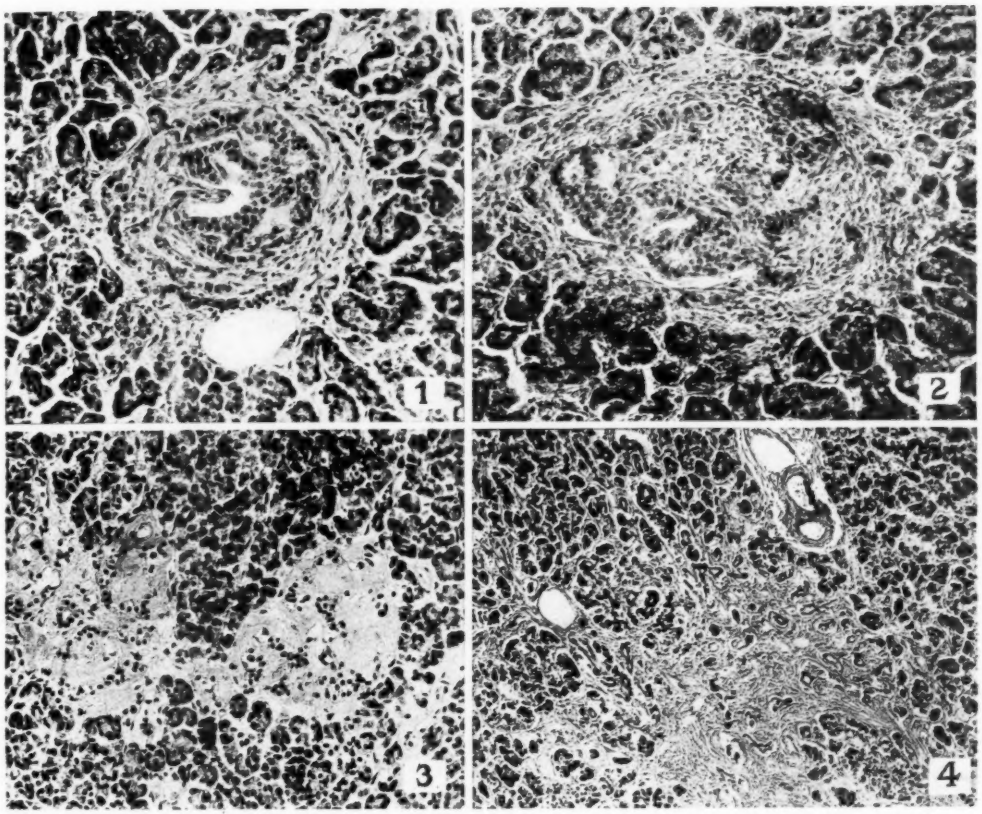

Fig. 1.[1] Photomicrograph of an islet from a section of the pancreas of Case 1. Note the fibrosis principally at the periphery of the islet. The epithelial cords in the center are still fairly intact.

Fig. 2. From same case as Figure 1. The fibrosis is considerably more advanced and there is a slight lymphocytic infiltration present. Both Figures 1 and 2 suggest the picture of chronic glomerulitis in the kidney.

Fig. 3. Photomicrograph of a section from the pancreas of Case 2. Two closely approximated islets are seen which have been completely replaced by hyaline material. A few epithelial remnants are visible. The patent capillaries are distinct. Several capillaries show greatly thickened hyalinized walls.

Fig. 4. Photomicrograph of a section from the pancreas of Case 3. The center of the lobule shows extensive fibrosis and atrophy of the acini. The arteriosclerotic changes in the arterioles are only slightly visible. The resemblance to the coarse fibrosis of the heart, resulting from coronary sclerosis, is very evident. The periphery of the lobule is fairly intact.

[1] All photographs and photomicrographs were made by Henry W. Morris, of the Department of Pathology, University of Minnesota.

gradual atrophy and sclerosis of the organ with relatively intact islets and no glycosuria. However, in later stages, from 30 to 120 days after ligation, he found sclerosis of the islets accompanied by glycosuria. This was especially prominent after injection of olive oil into the ligated ducts. Mankowski (30) and Sauerbeck (41) obtained similar results.

Kamimura (19) conducted very extensive experiments for the elucidation of the problem relative to the effect of duct ligation on the islets. His results are based on the study of one hundred rabbits. At the end of the first week after ligation he found very little change. At the end of the second week, the normal structure was lost—the tissue was scarcely recognizable as pancreas. There was

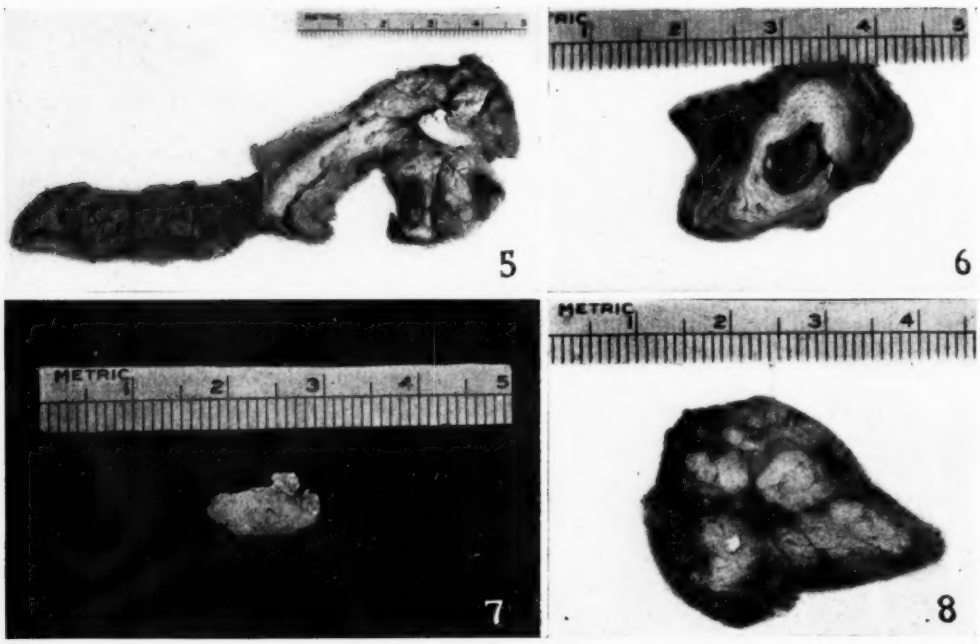

Fig. 5. Photograph of pancreas from Case 4. All of the succeeding photographs and photomicrographs are from the same case. Note the narrow body and tail up to the point of obstruction by the calculus. A portion of Wirsung's duct has been opened.

Fig. 6. Cross section of the pancreas in the region of the body. Wirsung's duct is enormously dilated. The wall appears fibrous and shows practically no areas of parenchyma remaining (cf. Fig. 8).

Fig. 7. The calculus after removal from the duct.

Fig. 8. Cross section of the head of the organ. Note the large areas of parenchyma present. In the center of one of these is visible a small white calcareous nodule occluding one of the smaller ducts.

atrophy with beginning sclerosis. In the fifth week, very few nests of parenchyma were visible, and the entire organ was replaced by connective tissue. However, the islets were still intact in the connective-tissue stroma. After 10 weeks there was contraction of the connective tissue and fat cells began to appear. In about 15 weeks there was scarcely any parenchyma visible and there was considerable fat replacement. The islets, however, remained normal throughout. In contrast to the findings, following the extirpation of the gland, examinations of the blood and urine showed neither hyperglycæmia nor glycosuria present during any stage of these experiments. He concludes that the ligation of the pancreatic duct leads to a slow, progressive atrophy of parenchyma with replacement by connective tissue, until there is practically no acinic structure left, but the islets remain intact. The animals suffered no digestive disturbances; they ate well and assimilated their food. They reacted normally after injection with adrenalin. The author is, therefore, convinced that the islets control the carbohydrate metabolism, since these animals appeared entirely normal as long as the islets were left intact for the production of the internal secretion; the profound alterations in the glandular portion of the pancreas had not had the slightest effect upon the utilization of sugar.

This author differs from Ssobolew (44) and others in his results, in that they revealed an absence of sclerosis of the islets even in the late stages of his experiments. Kamimura's results are identical with those obtained by Schultze (42) who had conducted similar experiments many years before him.

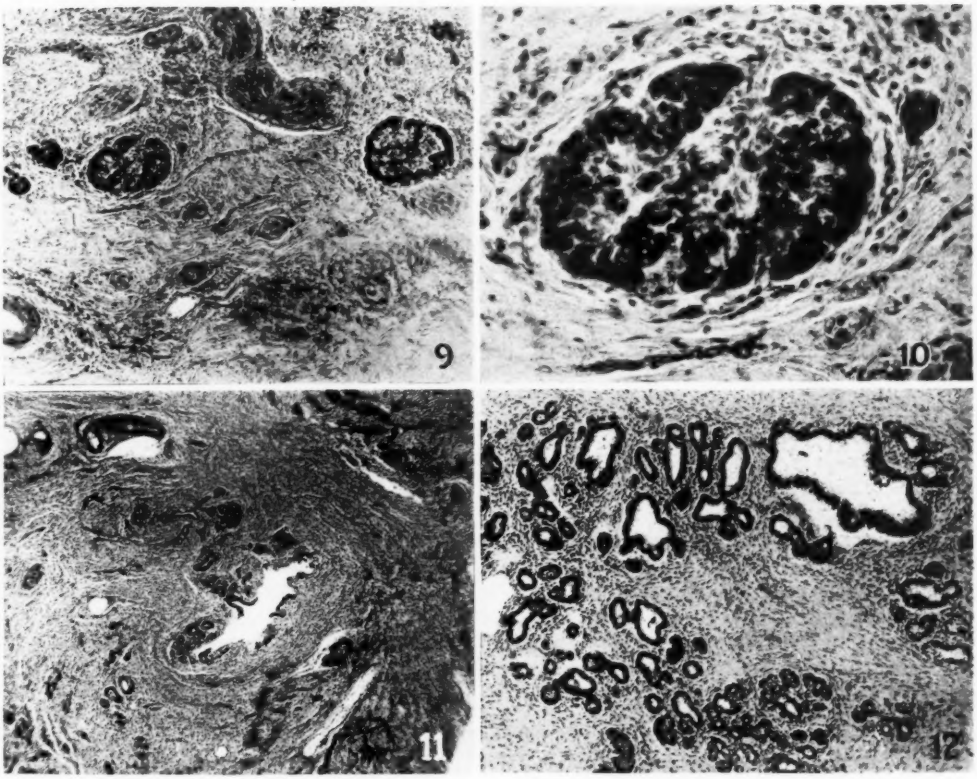

Fig. 9. Photomicrograph of section from the region of the tail. The nerve bundles and the islets are very prominent. There is a complete absence of acini. The stroma is of dense connective tissue with very little leucocytic infiltration. The two islets are fairly normal.

Fig. 10. High power photomicrograph of one of the islets shown in Figure 9. Note the almost normal appearance of the structure. The capillaries surrounded by cords of epithelial cells are well shown.

Fig. 11. Low power photomicrograph from section in region of the corpus showing complete absence of parenchyma. The stroma is of dense connective tissue with practically no evidences of inflammatory reaction present. The ducts show a mild grade of hyperplasia.

Fig. 12. High power photomicrograph of an area in a section taken near the caput. The enormous hyperplasia of the ducts is well shown. Young, newly formed, somewhat atypical acini are present in lower portion of picture.

MacCallum (29) performed an ingenious experiment of ligation and excision. He separated the distal third (tail) of the pancreas and ligated the duct draining this portion. Seven months later, when the separated part was found to be a mere thickening of the mesentery, the proximal (normal) two-thirds was excised. The operation was followed by a mild, transient form of glycosuria. Three weeks after the second operation, the thickened patch in the mesentery was removed. This time the operation was followed by a very extreme glycosuria. Microscopic examination of the excised tissue showed remnants of atrophic pancreatic tissue in the mesentery consisting almost entirely of ducts and masses of cells that morphologically appeared to be islets. However, he could not be sure of their identity. This case is interesting for the fact that the islets from so small a portion of the pancreas seemed to prove sufficient, temporarily at least, to prevent any but a mild transitory form of glycosuria.

Kirkbride (22) repeated the above experiment on guinea pigs. Her results entirely corroborate MacCallum's findings. She went

even further in successfully identifying the remnants of parenchyma as islets, by the use of Lane's (26) method of staining. She concludes that the islets are especially if not exclusively concerned with the maintenance of normal carbohydrate metabolism.

Experimental excision of pancreas. It is interesting to contrast the results obtained by excision of the pancreas with those obtained by a simple ligation of the ducts. Mering and Minkowski (32) as early as 1889 reported that total extirpation of the pancreas in dogs resulted in a severe and fatal diabetes. They believed that this result obtained from a lack of some substance which the pancreas secretes directly into the blood stream. Fahr (12) found that the gradual extirpation of the gland results in hypertrophy and hyperplasia of the remaining islets. Epstein and Baehr (11) found excessive hyperglycæmia in cats after total extirpation of the pancreas. The animals developed great thirst. The blood sugar rose from 0.084 per cent to 0.838 per cent within 6 days. The glycosuria gradually diminished, a condition which they assumed to be due to a diminished permeability of the kidneys.

It has been found that the extirpation of the pancreas in a gravid dog often results in no diabetes until after the birth of the puppies, when a fatal diabetes ensues. This would tend to show that the pancreatic hormone passes from the fœtus to the mother. In human cases of diabetes, women sometimes show an increased sugar tolerance during pregnancy which disappears after the birth of the fœtus.

In transplantation experiments, the transplant has often been found to undergo atrophy without resulting glycosuria. The excision of the atrophied and sclerosed transplant, however, has been followed by diabetes. Examination of the excised sclerosed tissue in these cases has shown that the islets had remained intact.

Pathology of the pancreas in diabetes. Bearing in mind the lesions encountered in the above mentioned ligation and extirpation experiments, let us pass over to the changes observed in spontaneous diabetes in man.

Cecil (6) working in the pathological laboratory of the Presbyterian Hospital, New York City, found that 87 per cent of the 90 cases of diabetes studied at postmortem showed definite lesions of either sclerosis or hyaline degeneration of the islets. Of these, the former was the most common. Eleven, or 13 per cent, appeared normal both grossly and microscopically. This is about the average percentage of normal appearing pancreases in diabetics as found by a large number of observers (Opie, 35a).

Heiberg (15) studied two cases of diabetes which resulted fatally, and found no noticeable changes present in the pancreas. He (16) found, however, that there were less than two-thirds as many islets in the tail of an apparently normal pancreas from a diabetic case as from a non-diabetic one. He, therefore, emphasizes the importance of the quantitative study of the islets as well as the qualitative. In our laboratory we have often been impressed with the scarcity of the islets in pancreases of diabetics in which the visible islets present no definite lesions. If it be assumed that there are cases born with a reduced number of islets, then such cases would be potentially congenital diabetics and would lack the normal functional reserve for proper carbohydrate metabolism. Such cases would require a relatively slight metabolic disturbance to bring about an actual glycosuria and hyperglycæmia. It is also possible that changes in the islets sufficient to produce an abnormal secretion may not be recognizable histologically in some cases. For, in our present state of knowledge, the existence of "functional" disturbances which present no characteristic gross or microscopic lesions cannot be denied. Nor can one overlook the fact that the pancreas may not be the only organ involved in the production of the disease. But this much has been observed to be true, both from experimental work and from clinical experience (as is well pointed out by Opie, 37) that, whenever diabetes is caused by a lesion of the pancreas, the lesion always involves the islets; and, conversely, whenever that organ is diseased, but diabetes is absent, the islets remain relatively free from involvement.

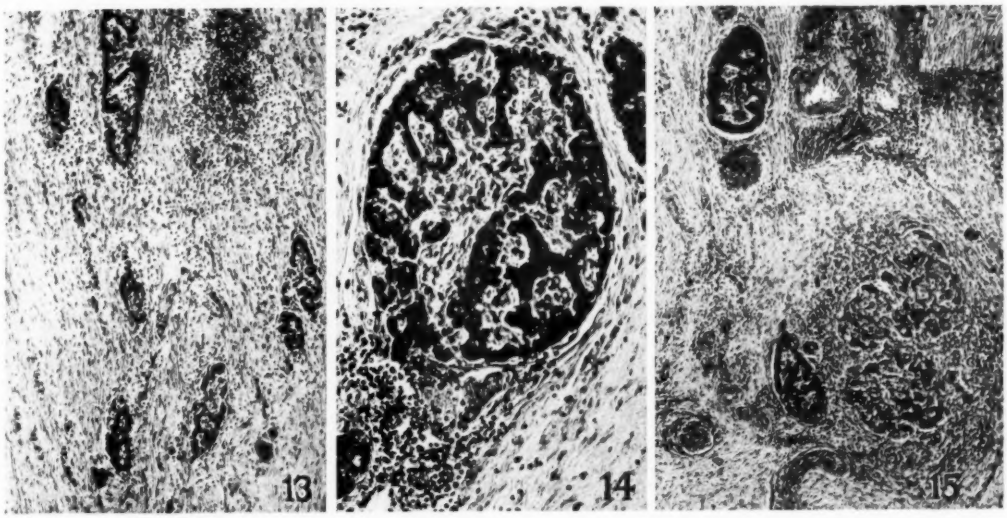

Fig. 13. Photomicrograph of another section near the caput. Note the large group of atrophic islets showing degeneration and infiltration with leucocytes. On the upper right, there is a large nest of polymorphonuclear leucocytes, indicating the presence of acute inflammation.

Fig. 14. High power photomicrograph of an islet showing a fairly advanced stage of fibrosis (cf. Fig. 2). At one end, there is a patch of lymphocytic infiltration.

Fig. 15. Photomicrograph of a section taken near the caput, showing a small nest of degenerating and atrophic acini still remaining in this region. There is a marked infiltration with polymorphonuclear leucocytes, lymphocytes, and a few plasma cells. The small islet shows degeneration and atrophy, which is probably due to the inflammatory reaction. The larger one is fairly normal.

REPORT OF CASES

CASE 1. Sclerosis of islets. A typical picture of a sclerosed islet, so often found in diabetes, is shown in Figure 1. The sclerosis begins around the tortuous capillaries by a proliferation of connective tissue between the endothelial lining of the blood channels and the epithelial cells. The epithelial cords become gradually atrophied and, in the late stages, disappear almost entirely, being replaced by hyalinized connective tissue. Figures 1 and 2 come from a case of a young woman, 21 years old, a student, who had been sick for 4 months, suffering from excessive thirst, increased appetite and loss of weight. She had not consulted a doctor until shortly before death. Urine examination showed 3.6 per cent sugar with large amounts of acetone and diacetic acid present. There was marked hyperglycæmia. At autopsy the pancreas weighed 50 grams and showed no gross lesions. Microscopically the organ showed an entirely normal picture except for the changes in the islets. These presented various stages of fibrosis. The earlier stages were represented by an increase of connective tissue around the capillaries; others showed a definite thickening of the capsules with an infiltration of a few lymphocytes; while the late stages showed an almost complete fibrosis of the islet with only a few scattered epithelial cells visible (Fig. 2).

CASE 2. Hyaline degeneration of islets. Figure 3 is from a case of diabetes in which the hyaline degeneration of the islets was very pronounced. A few remnants of epithelial cells are found scattered in some of the islets. This tissue was taken from a man 51 years old who had been sick in bed for 9 months because of prostration and weakness from diabetes. He suffered from a continual, intense thirst, frequent urination with polyuria and dyspnœa. He had lost a great deal in weight. Examination of the urine showed large quantities of sugar present. At autopsy the pancreas was found slightly decreased in size. Microscopically the acini showed a slight atrophy with a mild patchy increase of interacinic, hyalinized connective tissue. Practically all of the islets had undergone hyaline degeneration (Fig. 3) appearing as irregular minute foci of hyaline substance in a few of which were scattered isolated atrophied epithelial cells. Many of the capillary lumina remained patent. Not a single normal islet was found in the sections.

CASE 3. Arteriosclerotic changes in pancreas. Hoppe-Seyler (18) describes arteriosclerotic changes in the pancreas which result in diabetes. He considers the lesions to be comparable to the arteriosclerotic changes in the kidneys. The tail is principally involved, becoming atrophied and contracted. There is a chronic interstitial infiltration which

gradually penetrates the acini and leads to obliteration of the islets. I encountered one case in which the pancreas showed a peculiar type of arteriosclerotic change. This was in a woman 67 years old, who was brought to the hospital from her room where she had been found by her daughter moaning and in a semiconscious condition. She had had a history of "heart trouble" of many years' duration. The blood sugar was 0.37 per cent. At the autopsy there was found a moderate general arteriosclerosis which manifested itself most markedly in the pancreatic artery. The wall of this vessel was greatly thickened and its lumen decidedly narrowed. The sclerosis extended for some distance into the several pancreatic branches. The pancreas showed extensive fat infiltration between the lobules which were greatly reduced in size (pancreatic lipomatosis). Some lobules were reduced to only a few acini. In the centers of the larger lobules there were patches of fibrosis (Fig. 4), in which practically no normal acini or islets remained. Fine bundles of connective tissue radiated between the acini toward the peripheries of the lobules. Some of the blood-vessels, probably branches of the splenic artery, showed sclerosis. The greatest change was visible in the islets, very few of which approached the normal in appearance. They showed degeneration and necrosis of the epithelial cells together with some fibrosis. The patchy distribution of the connective tissue, which involved the acini as well as the islets, suggested the patchy fibrosis of the heart muscle following severe sclerosis of the coronaries.

The universally admitted facts, that the islets of Langerhans are involved in at least a majority of the cases of diabetes and that no case of alteration of the islets is encountered without an accompanying diabetes, make it evident that the islets secrete some substance or hormone into the blood which is necessary for the utilization of sugar by the tissues. Carlson (5) states that all evidence supports this view, and that true diabetes in man is primarily the result of pancreatic (islandic) deficiency. Hoppe-Seyler (18) believes that not only do changes in the islets determine diabetes mellitus, but that the degree of these changes determines the intensity of the disease, so that in the more severe cases the islets may be almost entirely destroyed.

Case 4. Pancreatic lithiasis. A disease which offers exceptional opportunity for the study of the microscopic changes in the pancreas, especially with reference to the relation of the islets to the acini and their ducts, is pancreatic lithiasis. I had the good fortune to encounter accidentally such a case while doing routine autopsies. The lesion, by its very nature, being of long standing, presents gradually progressive changes in the parenchyma that could be obtained in no other way, not even by experimental ligation of the ducts in animals.

This case is that of R. C., about 40 years old, who was brought to the Minneapolis City Hospital in coma at 3:30 p.m., on August 23, 1919. He had been found lying unconscious on the floor in his room. It was stated by an acquaintance of his that for several days he had not been well, and that he had been seen staggering about. During the last day or two he had not been seen at all until he was found lying unconscious in his room.

Physical examination at the hospital revealed a well developed but poorly nourished male, lying comatose in bed, but quite restless at times. The face was flushed; the expression distressed and anxious. Respiration was labored and at the rate of 28 per minute. The mouth was dry. The eyes were sunken; the pupils were dilated and equal, and reacted sluggishly to light. Blood pressure was 98/68. Examination of the urine gave albumin +, sugar ++, acetone and diacetic acid present. Examination of the spinal fluid was negative. The temperature between 97° and 99.4°F. Pulse 94 to 115. A diagnosis of diabetes with diabetic coma was made. He died at 6:30 p.m., on August 24, just 15 hours after admission.

The principal findings at the autopsy were as follows: The body was that of a well developed, fairly well nourished male, past middle age. There was no œdema and no jaundice present. There were large encrusted ulcers from 3 to 15 millimeters in diameter scattered over both shoulders, upper left chest posteriorly, and over left chest anteriorly. Some of these crusts are more than 5 millimeters in thickness, and on removal leave deeply punched-out ulcers. There is dark pigmentation of the skin over both hands from the middle of the forearms downward.

Examination of the chest shows nothing of importance other than congestion and œdema of the lungs.

In the peritoneal cavity nothing of interest is found outside of the pancreas. This organ shows a marked atrophy of the corpus and cauda which appear cylindrical, like a piece of rope, together measuring 11 centimeters in length and about 15 millimeters in diameter (Fig. 5). The corpus ends abruptly in a bulbous caput of about normal proportions, measuring 3.5 centimeters in diameter. On section the corpus and cauda are found to consist of a cylindrical tube possessing a fibrous wall from 3 to 5 millimeters in thickness. Minute opaque areas of parenchyma are visible over the cut surface. The lumen of the tube has a smooth wall and proves to be the pancreatic duct (Wirsung) markedly dilated. It measures from 4 to 6 millimeters in diameter (Fig. 6). Probing of the duct discloses an obstruction at about the center of the caput, which on sectioning is found to be a calculus, chalk-white in color and measuring 5 by 6 by 12 millimeters (Fig. 7). This calculus completely and firmly occludes the lumen (Fig. 5). Chemically it

is composed almost wholly of calcium carbonate, with only a trace of cholesterin present. The point of the obstruction appears to be in the region of a sharp curve in the course of the duct where the accessory duct (Santorini) is given off, whenever that duct is present. Efforts to locate the duct of Santorini are not successful. The caput appears relatively normal, showing considerable masses of parenchymatous tissue (Fig. 8). Small whitish calculi are found obstructing a few of the smaller ducts.

The microscopic study of the pancreas at different levels proved of unusual interest. In the region of the cauda, the sections showed a dense stroma of fibrous connective tissue in which were scattered numerous islets of Langerhans. Many of these islets were almost entirely normal, although there was no vestige of acinic tissue around them (Fig. 9). Some islets were decreased in size, having been reduced to a group of only a few cells, while others were distinctly hypertrophied to two or even three diameters. Figure 10 shows one of these isolated normal islets. The columns of epithelial cells surrounding the capillaries are well shown. The entrance of a capillary into the islet is clearly seen on the upper edge of the picture. A very few lymphocytes and fewer plasma cells are present in the stroma. The nerve bundles are unusually prominent and appear approximated (Fig. 9). The very striking feature, however, is the almost complete absence of acinic tissue.

Figure 11 is from a section in the region of the corpus. One of the smaller ducts with its branches is well shown. There is a slight attempt at regeneration of pancreatic tissue. This is best seen in Figure 12, where one can almost trace the development of young, slightly irregular acini as budding outgrowths from the terminal branches of the markedly hyperplastic ducts. This rather ineffectual attempt at glandular regeneration is quite analogous to the pictures often encountered in cases of portal cirrhosis of the liver, where the bile ducts also undergo enormous proliferation. Nothing was encountered to suggest attempts at regeneration of the islets.

Some areas showed beginning degeneration of the islets. Figure 13 shows an area in which a number of islets more or less atrophic and degenerated is imbedded in a dense connective-tissue stroma, free from acinic tissue, but in which there is an extensive infiltration of leucocytes. The large nest is composed mainly of polymorphonuclears, suggesting a rather recent infection. The more diffuse infiltration is composed mainly of lymphocytes, plasma cells, and a few eosinophiles.

From the study of the sections, it was quite apparent that degenerative changes in the islets were prominent only in those areas where an inflammatory exudate was present. In the areas of mere fibrosis, the islets remained quite normal. Figure 14 shows an hypertrophied islet, more than twice the normal size, on one side of which there is a dense lymphocytic infiltration. This islet shows a moderately advanced fibrosis with a definite atrophy of the epithelial cords. The capillaries are surrounded by layers of connective-tissue fibers. It is in a slightly less advanced stage of fibrosis than the islet in Figure 1.

Sections of the caput showed mainly normal parenchyma and, as is usual for this portion of the pancreas, very few islets were visible. Small nodules of atrophy and necrosis were scattered along those ducts that contained small calculi. Because of the presence of necrosis and very extensive leucocytic infiltration, mostly of polymorphonuclears, around these areas, one is led to conclude that these lesions were relatively recent in origin, and were probably associated with a local infection. Figure 15 shows a section taken from the corpus near the caput in which a small area of degenerating and atrophied acini still persists. The presence of degeneration and atrophy in the islet proximal to this area indicates its involvement in the inflammatory reaction. The distal islet is free from surrounding exudate, and appears fairly normal.

The study of this case reveals results that are remarkably similar to those found in experimental ligation of the ducts. The acinic parenchyma had completely disappeared in the tail of the pancreas where the atrophy and sclerosis uncomplicated by inflammatory reaction was most marked. Obviously, this area had been affected very early by the obstruction of the duct; nevertheless, the islets had persisted in a normal state (Fig. 10). In the body of the pancreas, and in the region of the head, where the pathological changes seemed to be more recent, there were evidences of infection, as revealed by the presence of extensive leucocytic infiltration. In these areas, the atrophy and sclerosis were accompanied by involvement also of the islets (Figs. 13, 14, 15). It is fair to assume that the diabetes very likely made its appearance at the time when the islets began to suffer. Cases of pancreatic lithiasis without diabetes (Allen, 1) are generally cases in which the islets remain free from involvement; in by far the majority of cases reported in the literature diabetes of a lesser or greater degree is associated with the lesion. The persistence of the islets at a time when there is a complete disappearance of the acini clearly demonstrates that they are structures entirely distinct from the acinic parenchyma and have no relation to the ducts. The consensus of opinion seems to be that simple obstruction

of the ducts, *per se*, does not result in glycosuria, but that only in the later stages, when an interstitial pancreatitis is superimposed, does diabetes ensue (Atkinson and Hirsch, 3).

Attempts at regeneration of the pancreas manifest themselves in the hyperplasia of the ducts (Fig. 12). Whether or not new islets may be formed in this process under favorable conditions is not certain. In the case under discussion, the regeneration progressed only as far as the formation of atypical acini.

ETIOLOGY AND SYMPTOMS

The formation of pancreatic stones has not been entirely explained, although bacterial infection undoubtedly plays an important part. Inflammatory changes in the ducts may produce a collection of material composed of exudate mixed with desquamated epithelial cells which may act as a nucleus upon which lime salts may crystallize. Kinnicutt (21) believes that pancreatic lithiasis is very probably infectious in origin. However, it has been found impossible to produce stones experimentally in animals.

Pain is a common symptom in stones of the pancreas and may be slight or severe and paroxysmal. Nevertheless, calculi have been found at autopsy in which there had been no history of any definite symptoms. The pain is generally localized in the epigastrium. Often the attacks are accompanied by nausea and vomiting. Chills and fever may or may not be present. A number of cases where jaundice has been associated with pancreatic lithiasis is on record. This was usually due to the presence of gall-stones simultaneously with the pancreatic stones. Sometimes the pancreatic stones by pressing against the common bile duct from without have brought on obstructive jaundice (Rindfleisch, 39).

Glycosuria and hyperglycæmia in most cases appear late in the disease, after there is an involvement of the islets by an intralobular pancreatitis. The diabetes may become of a very severe grade, as in the two cases reported by Heiberg (17). Transitory glycosuria is common early in the disease, during or immediately following the attacks of colic. Alimentary glycosuria, as revealed especially by the sugar tolerance tests, is a significant and frequent finding. Steatorrhœa is fairly common.

Keuthe (20) emphasizes Schmidt's test—the persistence of the nuclei in the muscle fibers found in the fæces—as a valuable diagnostic aid in conjunction with the sugar tolerance test. The finding of small white concretions in the fæces makes the diagnosis certain. Zesas (45) believes that colic in the upper part of the abdomen associated with the passage of stones by the bowel is an early symptom. Glaessner (13) diagnosed two cases by this method. Skaller (43) found stones in the fæces in one of his four cases of pancreatic lithiasis.

TREATMENT

As already mentioned, only a few cases of pancreatic calculi are diagnosed clinically. Of these, the treatment is entirely symptomatic other than surgical. The latter treatment has been successful in a small number of cases. Murray (34) operated on a patient for gall-stones, but found none present. After a severe attack 6 weeks later, he again operated, removing a stone from the pancreatic duct 12 millimeters in diameter. His patient made an uneventful recovery. Link (28) in one of his cases, found the head of the pancreas to be the size of a fist, and gritty like a sack filled with gravel. On opening the duct of Wirsung he found it greatly dilated and filled with faceted stones, the removal of which resulted in the recovery of the patient. Allen's case (1) at operation presented cysts the size of an orange, due to obstruction of Wirsung's duct by calculi. This patient died 5 days after the removal of the stones. Dowd (9) reports a case in which 30 soft mulberry-like stones embedded in pus were removed at operation from the pancreas. Similar stones had been passed in the fæces. The patient made a good recovery. Phillips (38) describes a case which had been operated on for gall-stones but none was found. The jaundice persisted and sugar appeared in the urine. The patient died in coma. At autopsy numerous stones were found in Wirsung's duct. Ruth's (40) case made good recovery after removal of a number of stones from the pancreatic duct, the largest of which measured

almost 5 centimeters in diameter. Moynihan (33), Gould (14) and Mayo-Robson (31) also report successful operations for pancreatic calculi.

It is of interest to note that there is little mention made of wounds troublesome because of fat necrosis as the result of the escape of pancreatic fluid. This may be partially explained by the fact that the secretion in these cases may be deficient in ferments.

SUMMARY

1. Pancreatic lithiasis is a very rare disease, which occurs mostly in males during the fourth decade.

2. The obstruction of the pancreatic duct leads to an advanced atrophy of the pancreas accompanied more or less by fibrosis. The islets may remain intact even when the acini disappear completely.

3. The islets are epithelial structures which are entirely independent of the acini and have no relation to or communication with the ducts.

4. Changes in the islets—such as degeneration, necrosis and fibrosis—generally occur late in the disease, probably as a result of a superimposed secondary infection, consequent to a prolonged stasis in the ducts.

5. In complete accord with the results obtained experimentally in animals, occlusion of the ducts by calculi in man does not result in diabetes mellitus unless there be actual injury to the islets.

6. Cases of pancreatic lithiasis presenting symptoms of hyperglycæmia and glycosuria reveal definite lesions of the islets at autopsy.

7. The present study bears out the conclusions that the islets secrete a hormone directly into the lymph or blood streams (internal secretion), which has a controlling power over carbohydrate metabolism.

8. Attempts at regeneration of injured pancreatic tissue manifest themselves in a definite hyperplasia of the ducts.

9. The principal clinical findings in cases of pancreatic lithiasis are colic-like epigastric pains often associated with temporary glycosuria, steatorrhœa, alimentary glycosuria, incomplete digestion of meat fibers as revealed by the persistence of the nuclei in muscle fibers in the fæces, and, occasionally, the presence of whitish or grayish pancreatic stones in the fæces; the late stages are often accompanied by diabetes mellitus.

10. Operations on the pancreatic duct are often successful. The danger of fat necrosis as a result of the escape of pancreatic fluid appears to be negligible.

11. The histopathology of the islets in diabetes falls into three main types, which are, in the order of their importance, as follows: fibrosis, hyaline degeneration, and arteriosclerotic changes. The pathogenesis of these lesions may not be very dissimilar to that of nephritis when taken in the broad sense. The differences in the intensity of the pathological changes in the kidney as compared with those in the pancreas may be explained by the marked differences in the characters of the two organs. In the kidneys, any glomerulitis or other changes in the glomeruli are followed or accompanied by alterations in the tubules; no such changes affect the tubules or acini in the pancreas, since the islets are entirely distinct from the latter structures.

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GUNSHOT WOUNDS OF THE BRAIN WITH RETAINED MISSILES[1]

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THE present report is an attempt to show what might be called the late results of metallic foreign bodies in the brain. During the period of the war, numerous communications set forth methods of handling cases of this sort at the primary operation immediately after the injury. Removal of the foreign material at the primary operation was universally advised if it could be accomplished without undue risk. As a result of the attempt at immediate, complete removal, a large majority of the patients returning to this country with gunshot wounds of the head, presented scars of varying degree without foreign bodies in the brain.

In a series of 192 patients with head wounds, which, except for a few accidents, were war injuries, 42 had metallic foreign bodies intra- or extra-cranial; 33 of the cases may be disregarded as the metal was superficial or in small particles, so that only 9 had retained metal of sufficient size and at a sufficient depth to demand serious consideration. These cases with an additional civilian with a retained pistol bullet, form the basis of this paper.

In reviewing the publications concerning primary operations, Harvey Cushing's paper[2] offers the best data for comparison. Accurate comparison cannot be made, since the series on which his data were based consisted of 219 cases, while our series numbers 192; but it is interesting to note the relative difference in the number of wounds of this type, the primary series furnishing 76 against 9 in the secondary series. These 9 cases are grouped according to the classification of the primary series into Grades V, VI, VIII.

Six of the patients of the secondary series were in Grade V, namely, wounds of penetrating type, with lodgment both of projectile and bone fragments. In the primary series, there were 41 cases in this grade. Five of the secondary cases, Cases 1, 2, 3, 5, and 7, were operated upon and recovered; the other patient, Case 9, was discharged without operation because the missile was inaccessible and was not causing symptoms.

Two of the secondary cases were in Grade VI, namely, wounds with ventricles penetrated or traversed (a) by bone fragments and (b) by projectiles. In the primary series there were 30 cases in this grade. One of the secondary cases, Case 6, wounded September 29, 1918, was operated upon on July 14, 1919; two large bullet fragments were removed and when cultured gave staphylococcus growth. During a second operation, November 26, 1919, for the removal of another fragment, a large cyst in the frontal lobe was opened; the cyst communicated with the ventricle and cultures gave growth of staphylococcus albus. The patient died on January 10, 1920. The other patient of this grade, Case 8, wounded July 4, 1918, was operated upon on June 5, 1919, for the removal of bone fragments from the left occipital lobe. A shell fragment in the left cerebral peduncle did not seem to be causing symptoms and was inaccessible, so that no attempt at removal was made. The fragments removed gave streptococcus hæmolyticus growth, and the patient died on June 25, 1919, of septicæmia.

The number of secondary cases is too small to permit of comparison of mortality percentages, but it is interesting to note that the most serious grade in the primary series was the only grade in the secondary series in which there was mortality.

One of the cases of the secondary series was in Grade VIII, namely, wounds with craniocerebral perforation. In the primary series there were 5 cases in this grade. In one case, Case 4, the wound of entrance was in the right occipital lobe, from which location a large shell fragment was removed immediately after the injury. In the left temporal region, there was a small skull defect, evidently the point of exit of some portion of the shell, and near which lay the small shell fragment, which we removed.

[1] Brit. J. Surg., 1918, v, No. 20.

[1] Read before the Southern Surgical Association, December, 1919.

In the experience of those doing primary operations at the front, infection caused chief concern in the patients not mortally wounded. In the primary series it was not possible to make cultures of all projectiles removed at operation, but in the several of which cultures were made, all showed organisms of greater or less pathogenicity. In the patients of this series, all of whom were operated on many months after the injury, infection was still the condition causing greatest trouble. In 7 cases the foreign body was removed and cultured; in 4 of these there was bacterial growth in the cultures; in 3 the cultures were negative. In another case in which there was no attempt to remove the metallic foreign body, an abscess at the site of the bone fragments was drained, cultures from which gave bacterial growth.

Organisms were found in various stages of activity, ranging from the entirely dormant stage, Case 6, through the small abscess not causing symptoms, Case 1, to the large abscess, with prominent pressure symptoms, Case 2, and the abscess with pressure symptoms and septicæmia, Case 8.

It has long been recognized that the mere presence of a foreign body in the brain is not incompatible with life, nor does it necessarily disturb function. In the reconstruction work, however, it was planned to have all soldiers discharged in a condition as nearly normal as possible. The patient was always desirous of having foreign material removed from the brain if it could be accomplished without undue risk. In some instances the removal of the foreign body was necessary as a preliminary to the repair of skull defects, as it is unwise to repair defects if the brain contains foreign bodies.

Localization of the metal was accomplished chiefly through stereoscopic roentgenograms; the fluoroscope, however, was useful in the cases with large pieces of metal.

The operation was carried out in all cases, except Case 1, through a small incision. In Case 1 a unilateral suboccipital scalp flap was turned down, but only a small bony opening made.

The magnet was of less use in these cases than in the handling of cases immediately after injury, since the foreign body in all of our patients was more or less firmly fixed in the brain tissue. This was true not only in those cases in which there was no infection, but also in those in which there was abscess formation. In Case 1 the bullet was plainly visible superficially in the right cerebellar hemisphere; the distal portion could be seen projecting into the abscess cavity, and the proximal portion firmly held in the wall of the abscess. In Case 2, in which there was a large abscess in the temporal lobe, the foreign body was not found in the abscess cavity, but located at a subsequent operation, firmly encapsulated in the posterior wall of the abscess. After dislodging the body, the magnet might have been used for the purpose of dragging it from the brain substance, where it rested at a considerable depth, but this was easily accomplished with a pair of alligator forceps.

Small folded rubber tissue drains were always immediately placed in the cavity from which the metal was removed. The metal was always carried directly from the brain to the culture tube and the culture examined daily for several days. If at the end of 96 hours there was no growth in the culture the drains were removed; but in the case of a positive culture the original drains were allowed to remain for a period of several months, during which there was always active drainage.

CASE 1. Pvt. P. L. Right occipital penetration by machine-gun bullet which lodged in the right cerebellar hemisphere: extraction of bullet and drainage of abscess; recovery.

The patient was wounded September 27, 1918, and admitted to a front line hospital in good condition. There was no attempt made at that time to remove the bullet.

When brought under observation at General Hospital No. 2, Fort McHenry, Maryland, in April, 1919, the roentgen-ray findings (Figs. 1 and 2) were the only clinical evidence of the presence of the bullet. Removal of the missile was advised because of its large size and the fact that the procedure seemed to offer no difficulties.

Operation, May 19, 1919 A unilateral cerebellar exposure was made (Fig. 3). After deflecting the right flap a small portion of bone was removed and a transverse incision made in the dura. There were a few delicate adhesions between the dura and the pia-arachnoid. An exploring needle passed 0.5 cm. into the hemisphere encountered the bullet. Division of the cortex resulted in a free flow of pus. Further examination revealed a small abscess cavity in the

right cerebellar hemisphere which contained about 3 cubic centimeters of pus. Into the abscess cavity the distal two-thirds of the bullet projected while the approximate one-third was firmly encapsulated in the right wall of the abscess. The bullet was removed and immediately placed in culture media, examination of which later showed a growth of staphylococci. Folded rubber tissue drains were placed in the abscess cavity and brought to the surface at the outer extremity of the transverse incision.

Forty-eight hours after operation there was some headache and elevation of temperature. Drainage continued until November 1, 1919, when there was complete healing. At no time during this period was there evidence of disturbance of the cerebellum.

The case illustrates the course of a septic foreign body with a latent stage, through an attempt at autosterilization terminating in a serious inflammatory lesion. The abscess, which was found during the operation for the removal of the bullet 234 days after the injury, had not been suspected, since the patient presented no neurological disturbance. Had the operation been deferred until the appearance of troublesome symptoms, there would have been much greater destruction of the cerebellar tissue and the chances of immediate and ultimate recovery greatly diminished.

CASE 2. Pvt. E. M. Shell fragment wound left malar region: immediate recovery good; five months after injury there were symptoms of brain abscess; left subtemporal decompression, January, 1919; drainage of temporal lobe abscess, May, 1919; removal of missile in June, 1919; recovery.

The patient was injured by a bursting shell on August 17, 1918, and remembered nothing concerning his injury until several days afterward, when he found himself in General Hospital No. 9 at Rouen. He then had numbness over the area of distribution of the left fifth cranial nerve and weakness of the muscles of the left side of the face. Eight days after the injury, there was improvement in the muscle weakness. September 7, 1918, he was able to walk a few steps, but his memory was poor; there was slight aphasia and diminution of vision, especially of the right eye. There were numerous wounds, all of which healed promptly except the one in the left malar region.

He was admitted to U. S. General Hospital No. 2, Fort McHenry, Maryland, November 27, 1918, when the chief points of the examination were poor vision, especially of the right eye, unpleasant sensations and hyperæsthesia over the area of the left trigeminal nerve and weakness of the muscles of the left side of the face. Over the left malar region, just below the outer canthus, there was a small scar which marked the site of one of the original wounds. The roentgen-ray photograph showed a metallic foreign body in the posterior inner border of the left middle cranial fossa (Figs. 4 and 5).

About January 15, 1919, the patient complained of severe headache and was somewhat drowsy. On January 19, the headache was more severe and the patient was very drowsy. His blood pressure, was 110 to 70 millimeters mercury. A lumbar puncture revealed fluid under slightly increased pressure, with 155 cells per cubic centimeter, negative bacteriologically. The leucocyte count was 15,000 cells per cubic centimeter. His pulse ranged between 45 and 56, and his highest temperature was 99.2°.

Operation, January 21, 1919. A left subtemporal decompression was done by Major A. R. Calvin and Major B. T. Stookey. Because of the critical condition of the patient only a short search was made for the foreign body. The operative recovery was tedious.

On January 29, 1919, a small abscess at the site of the original injury in the left malar region was incised. This tract remained open until after complete drainage of the temporal lobe abscess.

Operation, May 23, 1919, drainage of abscess of left temporal lobe. The previous decompression was bulging greatly so that the abscess could not be entered at this point. After resection of 1.5 centimeters of the left zygoma (Fig. 6) the point of entrance of the missile, in the floor of the middle fossa of the skull, was exposed. A probe passed through the sinus in the left malar region was used as a guide in locating the opening. The defect was increased by removing the lateral rim, when a dissector was passed into the brain substance, and a large amount of pus was evacuated. Only a hurried search was made for the missile because of the condition of the patient and the fact that the roentgen-ray indicated its position in the posterior inner part of this fossa. After evacuation of the pus a small rubber tube (Fig. 7, *a*) and several drains made of gutta-percha were inserted into the cavity. Around these drains the wound was loosely closed.

Following the operation, there was gradual return to consciousness, and the immediate recovery was quite satisfactory. Improvement of vision was noticed within a few days.

Operation, June 7, 1919, removal of metallic foreign body from left temporal lobe. An incision about 4 centimeters in length was made above and posterior to the left ear. The skull was entered at the extreme posterior part of the middle fossa; the dura was elevated from the posterior wall of the middle fossa to a depth of about 5 centimeters; the foreign body was not located. An incision was then made in the dura and the cortex of the temporal lobe elevated to a distance of 5 centimeters from the dura, and the metallic foreign body was encountered (Fig. 8). The body was firmly fixed so that a magnet was useless. After dislodging the metal it was seized in alligator forceps and removed. Small, folded, rubber drains were placed to the depth of the tract through which the metal was removed. The

operation was completed by loosely closing the wound about them.

In entering the skull at this time great care was taken to work without coming in contact with the bulging cortex at the site of the previous decompression. The bony opening of the skull made for the removal of the body is seen in Fig. 7 at *c*.

The postoperative recovery was entirely satisfactory. There was profuse drainage at the site of the first operation and slight drainage at the site of the second operation for many weeks.

After recovery from the immediate effects of the injury, on August 17, 1918, there was no evidence of increase of intracranial pressure until January, 1919. There were symptoms of neurological disturbance, however, and it is fair to suppose that the lack of symptoms of increased pressure was due to the very gradual enlargement of the abscess. The decompression on January 21, 1919, certainly bridged a critical period, as did the opening of the abscess in the left malar region on January 29, 1919, for the bulging at the site of decompression and drainage in the left malar region continued until the abscess was drained, May, 1919. Just prior to the operation, however, the bulging reached its maximum and the abscess was too large to be drained through the small sinus.

The method of attack in draining the abscess was somewhat different from that usually adopted, and gave excellent results, because of the low position of drainage and the fact that the abscess was entered at a point where the cortex was adherent to the dura.

CASE 3. Pvt. E. A. Machine-gun bullet wound in right frontal region: small metallic foreign body and bone fragments in the cortex; small traumatic cyst; operation: removal of metallic and bony foreign body; recovery.

The patient was injured November 6, 1918, and immediately after the injury was operated on at Mobile Hospital No. 1. His recovery was good.

He was examined at U. S. General Hospital No. 2, Fort McHenry, Maryland, May, 1919. There were two large scars and a small pulsating area in the right frontal region. Except for headache the neurological condition was normal. Roentgenograms revealed bony foreign bodies (Figs. 9 and 11) well within the cortex and a metallic foreign body (Figs. 9 and 10) just within the bony defect.

Operation, July 12, 1919, removal of metallic foreign body. The bony foreign bodies were not located.

Operation, August 12, 1919, evacuation of traumatic cyst. During the search for the bony foreign bodies a firmly walled cyst, containing about 20 cubic centimeters of clear fluid was encountered. The cyst was evacuated and a search made for the bony foreign bodies, but without success. With a syringe, fluid was aspirated from and air immediately injected into the cyst and a roentgen-ray plate made. In Figure 11 the outline of the cyst is definitely seen and below its lower portion the distinct shadows of the bony foreign bodies.

Operation, August 27, 1919, removal of multiple bony fragments from right frontal lobe. The cyst was again opened and a small exploring needle passed into its wall at various points. Fragments of bone were located beneath the lower wall, encapsulated in firm tissue. Rubber drains were placed to the depth of the cavity and the operation completed.

Cultures of the fragments were negative for bacterial growth, and there was no drainage at the site of the wounds. The rubber tissue drains were removed a few days after the operation. The operative recovery was satisfactory, but the patient continued to complain of headaches, and there was slight bulging at the site of the defect 4 months after operation. Repair of the skull defect will be postponed until there is no bulging.

The localization of the bony fragments was greatly facilitated by the injection of air into the cyst, as can be seen in Figure 11. The cyst cavity was distinctly outlined above the bony fragment shadows, so that it was evident the fragments were to be found in the cerebral tissue well below the inferior border of the cyst.

CASE 4. Sgt. P. J. G. Gunshot wound in left occipital region; small metallic foreign body in left temporal lobe; operation; removal of metallic foreign body: recovery.

The patient was injured October 1, 1918. At a forward hospital a large metallic foreign body was removed from the posterior portion of the right hemisphere. For a short time after the injury there was weakness of the right upper and lower extremity, with diminution of sensation.

He was admitted to U. S. General Hospital No. 2, Fort McHenry, Maryland, January 15, 1919. The paralysis had cleared up. There was right homonomous hemianopsia. The roentgen-ray examination showed a small bone defect in the right occipital region, a second small defect in the left temporal region, and a metallic foreign body 6 by 4 millimeters in the left temporal lobe.

Operation, June 1, 1919, removal of small metallic foreign body, left temporal lobe. An incision 4 centimeters in length was made over the left temporal region defect, which was slightly enlarged backward. The dura was opened above the middle meningeal artery, and there were fine adhesions between the dura and the pia-arachnoid. The metallic body was easily located at a depth of 8 millimeter in the cortex. The metal was placed in culture immediately after removal. Recovery was prompt; and as there was no bacterial growth in the culture media after 96 hours, the drains were removed.

CASE 5. Pvt. R. R. Gunshot wound in midfrontal region; metallic foreign body deep in the substance of the left frontal lobe; operation; removal of the metallic foreign body and repair of defect of skull; recovery.

The patient was injured on October 4, 1918; his steel helmet was penetrated and he was immediately rendered unconscious. For a short period there was

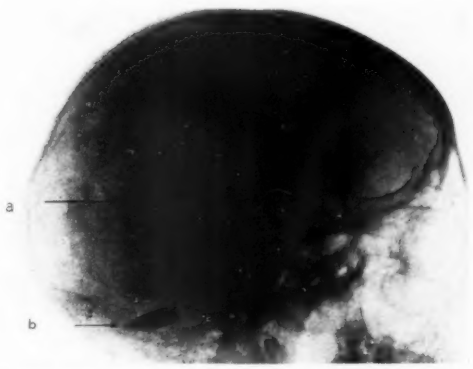

Fig. 1. Case 1. *a*, Point of entrance; *b*, machine-gun bullet in right cerebellar hemisphere.

Fig. 2. Case 1. *a*, Machine-gun bullet in right cerebellar hemisphere.

weakness of the left leg. For several weeks this leg was easily exhausted. His memory was poor.

He was admitted to U. S. General Hospital No. 2, Fort McHenry, Maryland, February 7, 1919. There was a scar 11 centimeters in length extending across the frontal region at the hair-line; beneath the scar there was a large bony defect. Memory for recent events was slightly impaired; there was some disorientation for time. The deep reflexes were normal. The roentgen-ray revealed a metallic foreign body 0.5 by 1 centimeter and the large skull defect in the frontal bone (Figs. 12 and 13).

Operation, August 14, 1919, removal of metallic foreign body. An incision 4 centimeters in length was made in the left temporal region and a small area of bone removed. The metallic foreign body, encountered at a depth of 3 centimeters within the cortex was loosely encapsulated and easily removed without bleeding or trauma to the cortex. The metal was immediately placed in culture and small rubber tissue drains placed to the depth of the cavity from which it was removed. Recovery was good. As there was no bacterial growth in the culture, the rubber tissue drains were removed on the fourth day. On September 9, 1919, the skull defect was repaired.

Postoperative recovery was good.

The comparatively small size of the missile and the absence of symptoms caused considerable hesitation in attempting its removal. After a delay of several weeks, during which the patient was kept under observation for possible symptoms, he became very impatient and expressed a desire to have the body removed, rather than continue in an uncertain state. Actual removal offered little difficulty, and convalescence was quick in the absence of organisms.

Case 6. Pvt. V. C. Fragmented rifle bullet in left frontal lobe; large skull defect; operation, July 14, 1919; removal of two large bullet fragments; second operation, November 26, 1919, drainage of traumatic cyst of left frontal lobe; death. January 10, 1920.

The patient was wounded September 29, 1918, by a rifle bullet; his steel helmet was penetrated and he was unconscious for several days. There were no focal symptoms.

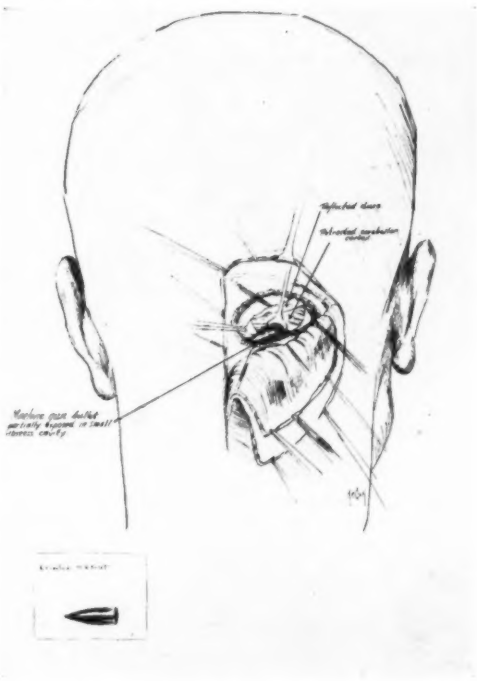

Fig. 3. Case 1. The sketch shows the portion of the bullet which projected into the abscess cavity.

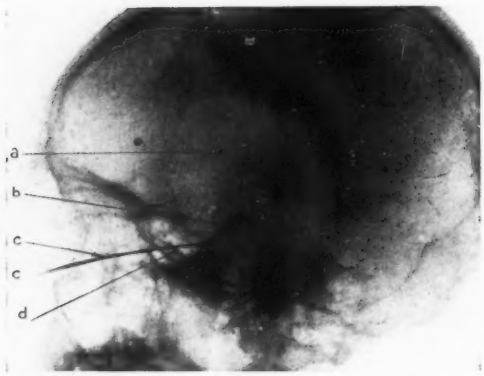

Fig. 4. Case 2. *a*, Marks the center of a skull defect, the result of the left subtemporal decompression. *b*, Shell fragment in middle fossa of skull. *c*, Probe passed through the sinus, beginning in the malar region and extending to the shell fragment. *d*, Floor of the middle fossa of the skull.

He was admitted to U. S. General Hospital No. 2, Fort McHenry, Maryland, April 2, 1919. The neurological examination was negative, except for headaches and slight mental change. The patient was inclined to treat his condition lightly, was cooperative, but seemed rather irresponsible. There was a large pulsating defect (Figs. 14 and 15). Three shadows indicating metallic foreign bodies were seen in the roentgen-ray plates (Figs. 14 and 15). In addition there were many small foreign bodies, all of which were extracranial.

Operation, first stage, July 10, 1919, exploration for metallic foreign bodies in left frontal lobe. As the bodies were not easily located, silver clip markers were placed on the divided dura and stereoscopic roentgen-ray plates made again.

Operation, second stage, July 14, 1919. Two large metallic foreign bodies to the lateral side of the left temporal lobe were found firmly encapsulated at a depth of 1.5 centimeters below the surface of the cortex. They were removed with some difficulty, as the surface of the bodies obtained was very rough, and great care was necessary to avoid traumatizing the cortex. Rubber tissue drains were placed to the depth of the cavities from which the bodies were removed and the wound closed. The metal was immediately placed in boullion culture.

Twenty-four hours after operation staphylococcus albus was found in the culture, and there was a free drainage of pus at the site of operation. The general condition was good until the ninth day, when, following a period of activity (walking about the ward), there was a series of nine convulsions. These were finally controlled through the use of sedatives. Pus continued to drain for 3 months, during which time the neurological condition of the patient was practically negative, except for the evidence of mental deterioration as noted above.

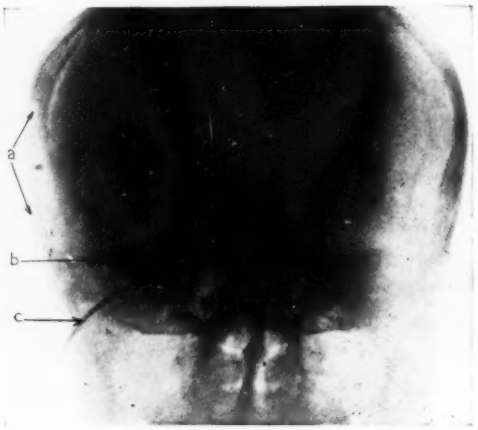

Fig. 5. Case 2. *a*, Marks the skull defect, the result of the left subtemporal decompression. *b*, Shell fragment in middle fossa of skull. *c*, Probe passed through the sinus, beginning in the malar region and extending to the shell fragment.

Operation, November 26, 1919, drainage of traumatic cyst of left frontal lobe. The left frontal lobe was explored through a 4 centimeter incision over the lower portion of the defect in the left frontal bone, and extensive adhesions were encountered between the dura, the cortex, and the floor of the anterior fossa. The dissection was carried to within a few millimeters of the foreign body, when there was a free flow of fluid, due to the rupture of a cyst. As communication with the ventricle was suspected and the presence of dormant organisms feared, small rubber tissue drains were placed to the depth of the wound and the operation terminated; on the rubber tissue drains small silver clip markers were placed.

Immediately after the operation there was a slight rise of temperature and headache and postcerebral rigidity. This condition continued until the fifth day, when there was a gradual clearing up of all troublesome symptoms. There was free drainage of fluid containing staphylococcus albus at the site of operation. The roentgen-ray plates (Fig. 16) showed the silver clip markers placed on the rubber tissue drains on a plane horizontal with and 8 millimeters anterior to the metallic foreign body. Drainage at the site of the frontal exploration ceased January 1, 1920, though the drain was not removed. The general condition was satisfactory; there was no headache and the temperature and pulse were normal. On January 10, 1920, 45 days after the frontal exploration, the patient, without warning, had a series of convulsions, about twenty in all, and died. Autopsy revealed complete obliteration of cyst with yellow gelatinous fluid in left lateral ventricle.

In this patient the ventricle was evidently penetrated at the time of the injury, since there was a

large communication between the cyst and the ventricle at the time of the second operation. After removal of the large fragments at the first operation there was active drainage, but the inflammation was well taken care of by the brain tissue. Drainage of pus was to be expected after the second operation, and it is believed that there would have been no difficulty except for the communication with the ventricle, which made complete drainage impossible. Obliteration of the cyst with distention of the ventricle at autopsy seems to bear out this opinion.

CASE 7. Corporal A. L. Metallic and bony foreign bodies in right parietal lobe near the mid-line; left hemiplegia, severe headaches; operation; removal of metallic and bony foreign bodies; improvement of hemiplegia and headaches; recovery.

The patient was wounded October 22, 1918, by a machine-gun bullet and was unconscious for 5 days.

He was admitted to U. S. General Hospital No. 2, Fort McHenry, Maryland, April 3, 1919. In the right parietal region there was a large scar extending from the mid-line to the mastoid region. Beneath the scar there were two small bony defects, one near the mid-line and the other low in the parietal region (Figs. 17 and 18). At the site of the defect, near the mid-line, there was a small sinus from which there was a slight amount of pus exuding. In the roentgenogram there were shadows suggesting bony

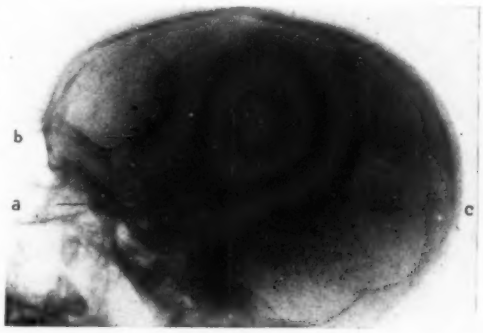

Fig. 7. Case 2. *a*, Rubber drainage tube inserted into left temporal lobe abscess. Note the angle at which the tube extends. *b*, Center of the skull defect of left subtemporal decompression. *c*, Small defect through which the metallic foreign body was removed as shown in Figure 8.

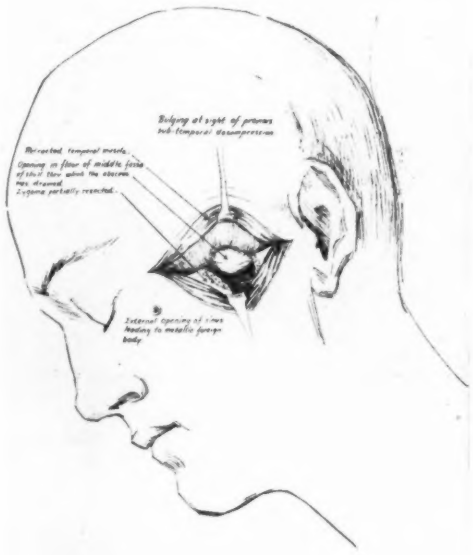

Fig. 6. Case 2. Diagrammatic sketch showing resection of zygoma and defect in floor of middle fossa of skull, through which the abscess was drained.

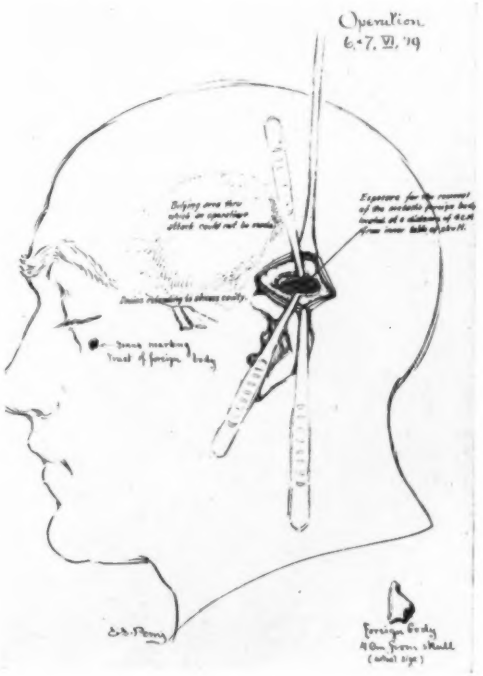

Fig. 8. Case 2. Diagrammatic sketch showing the operative wound through which the shell fragment was removed from a depth of 5 centimeters in the left temporal lobe.

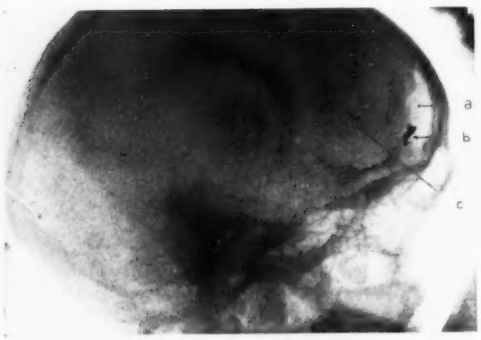

Fig. 9. Case 3. *a*, Small defect of skull in right frontal region. *b*, Shell fragment lying superficially in the right frontal lobe. *c*, Bone fragment lying deep in the right frontal lobe.

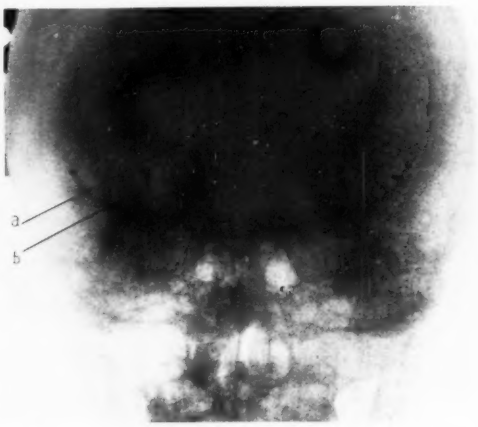

Fig. 10. Case 3. Anteroposterior view of Figure 9. The letter indications are the same. The bone fragments cannot be seen in this plate.

sequestra at the depth of this sinus. Anterior to the opening near the mid-line were two metallic foreign body shadows (Figs. 17 and 18).

Operation, June 8, 1919. excision of scar in right parietal region and removal of sequestra from right parietal lobe. Under ether anæsthesia the entire scar was excised and the sinus at the site of the defect explored to a depth of 1.5 centimeters. Small fragments of bone were encountered and removed. The sequestra were placed in culture media and rubber tissue drains inserted into the depth of the cavity from which the sequestra had been removed.

Forty-eight hours after the operation there was severe twitching of the muscles on the left side of the body without loss of consciousness. This cleared up after the administration of large doses of bromide of potassium. The cultures revealed staphylococci 48 hours after the operation. Following the operation there was some slight improvement of the hemiplegia. The wound continued to drain for several weeks.

Operation, August 29, 1919, removal of metallic foreign bodies from the right parietal lobe. A semicircular incision 6 centimeters in length was made in the right parietal region, extending anteriorly from the defect near the mid-line. This defect was enlarged anteriorly, and, after great difficulty, the small foreign body was located at a depth of 2 centimeters below the dura. It was firmly fixed in a capsule. The large body was found 0.5 centimeter

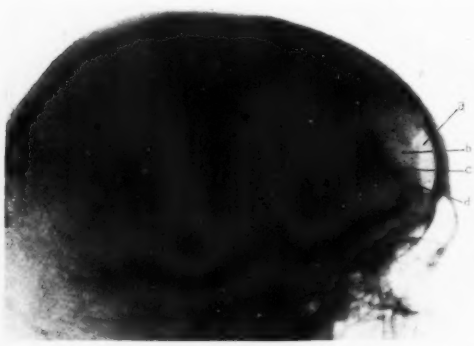

Fig. 11. Case 3. *a*, Skull defect. *b*, Traumatic cyst into which air has been injected. *c*, Shadows of bone fragments which were removed. *d*, Small extracranial foreign body which no attempt was made to remove.

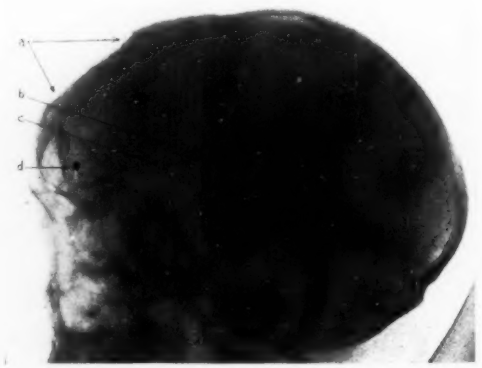

Fig. 12. Case 5. *a*, Skull defect through which the metallic foreign body, *b*, entered. *c*, A lead marker pasted on the lateral surface of the head. *d*, A similar marker placed over the superorbital ridge for the purpose of localizing in the stereoscopic plate the metallic foreign body.

Fig. 13. Case 5. The anteroposterior view of Figure 12. The letter indications are the same.

below the surface, also firmly encapsulated. Removal of the bodies was accomplished with only slight injury to the cortex, during which there was practically no bleeding. The metal was immediately placed in culture media and drains inserted to the depth of the cavities.

Recovery was prompt. There was no growth in the cultures during 96 hours. The drains were removed on the fourth day. The headaches were improved but were still more or less troublesome. There was slight improvement in the left hemiplegia, due in large part, no doubt, to physiotherapy.

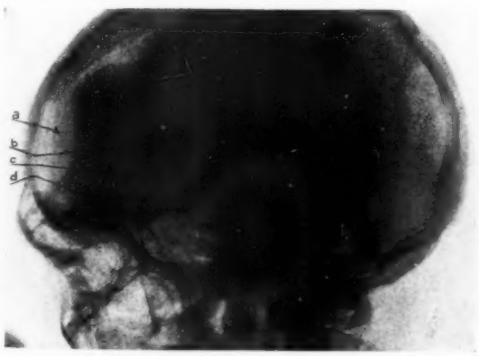

Fig. 14. Case 6. *a*, Large defect of the skull in the left frontal region. *b*, Jacket of the rifle bullet. *c*, The distal portion of steel core of rifle bullet which after removal fitted nearly into the jacket. *d*, Proximal portion of steel core. The small metallic foreign body shadows were practically all extracranial and unimportant.

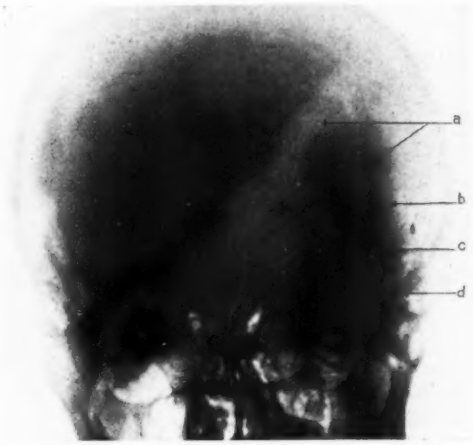

Fig. 15. Case 6. Anteroposterior picture of Figure 14. The letter indications are the same. Note the depth of *d*.

CASE 8. Sgt. D. F. Gunshot wound of left occipital region; abscess of left occipital lobe; metallic foreign body in left cerebral peduncle; operation; drainage of abscess; death due to septicæmia.

The patient was wounded July 4, 1918. There was immediate, complete right hemiplegia. The patient did not lose consciousness. He was taken prisoner by the Germans, and while in a German hospital a piece of shrapnel was removed from the left occipital lobe. The arm and leg gradually improved and in November, 1918, the patient began to walk.

He was admitted to U. S. General Hospital No. 2, Fort McHenry, Maryland, March 24, 1919. There was spasticity of the right upper and lower ex-

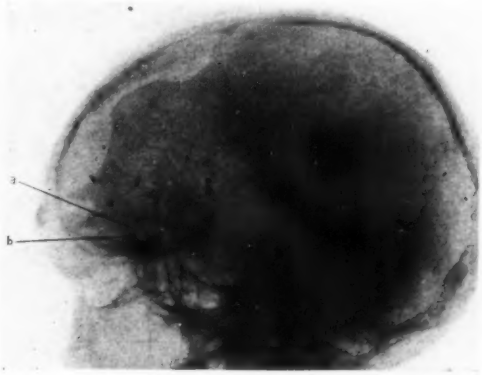

Fig. 16. Case 6. *a*, Proximal portion of steel core of bullet. *b*, Silver clips placed as markers on rubber tissue drain. Note the absence of large skull fragments seen in Figures 14 and 15.

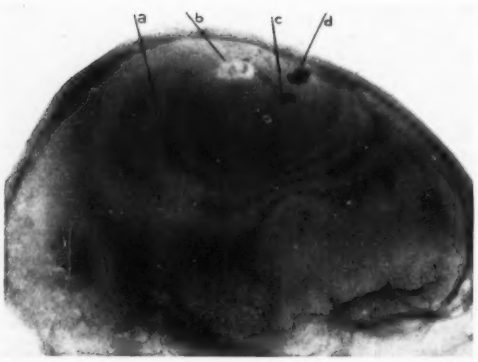

Fig. 17. Case 7. *a*, Small defect in right parietal bone. *b*, Small skull defect near the mid-line in which there are several small metallic foreign body shadows. *c* and *d*, Metallic foreign bodies in the cerebral cortex.

tremities. The patient was able to walk without assistance. His hand-writing was poor, very coarse and irregular. There were occasional headaches. At the site of the wound in the occipital region there was a small sinus from which yellow pus exuded. The roentgen-ray examination revealed a bone defect in the left occipital region. Beneath the defect there were several shadows, indicating bony sequestra deep in the brain substance, and a metallic foreign body (Figs. 19 and 20), just to the left of the mid-line in the anteroposterior plate, and about 2 centimeters above the shadow of the external auditory meatus in the lateral plate. Because of suppuration in the left occipital lobe, removal of the bony sequestra was recommended, while the depth of the metallic foreign body contra-indicated any attempt at removal.

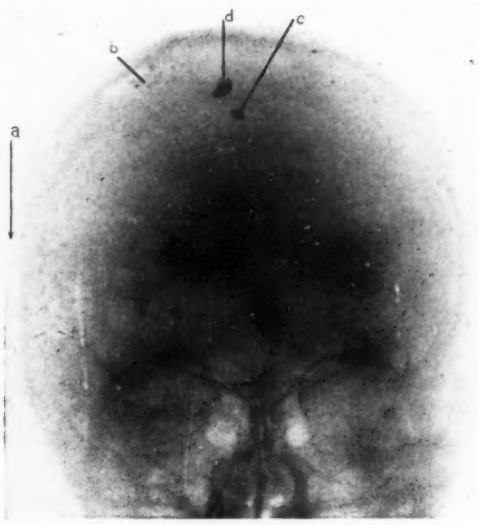

Fig. 18. Case 7. Anteroposterior view of Figure 17. The letter indications are the same.

Operation, June 5, 1919, removal of sequestra. Under ether anæsthesia a small incision was made at the site of the sinus in the left occipital region. Several small sequestra were removed from a depth of about 2 centimeters. During this removal it was noted that the sequestra seemed to be lying loosely in the tissue. The fragments were immediately placed in culture media and small rubber tissue drains inserted into the cavity.

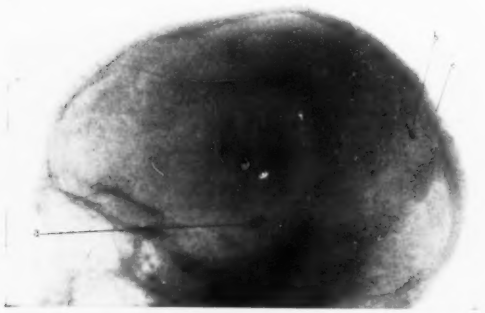

Fig. 19. Case 8. *a*, Shell fragment, no attempt to remove which was made because of its depth. In the occipital region there was a small skull defect, *c*, which was the point of entrance. Beneath the defect, there was an abscess containing bone fragments, *b*.

Fig. 20. Case 8. Anteroposterior view of Figure 19, showing the metallic foreign body at *a*.

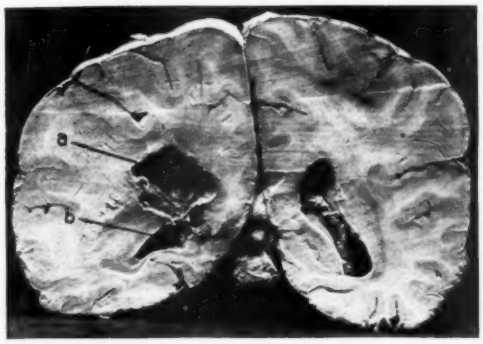

Fig. 21. Case 8. View of the posterior surface of a transverse section of the brain, showing the abscess at *a*, in close proximity to the ventricle, *b*.

Fig. 22. Case 8. Anterior view of a transverse section of the brain some distance in front of Figure 21, showing the metallic foreign body in the left cerebral peduncle. Note the absence of softening or other evidence of irritation.

Forty-eight hours after operation the cultures showed a growth of streptococcus hæmolyticus; headaches gradually increased and for several days there was stupor with slowing of the pulse and choked discs.

Operation, June 22, 1919, drainage of abscess of left occipital lobe. A small opening was made anterior to the defect. An exploring needle was introduced into the occipital lobe and about 30 cubic centimeters of greenish pus evacuated. Rubber tissue drains were placed in the cavity.

Twenty-four hours after operation, there was a sharp rise of temperature to 105° and increased pulse rate of 180. Within a few hours there was a rapid decline of temperature. The following day there was another sharp rise of temperature while the pulse rate remained rapid. The patient did not present the appearance of one suffering with meningitis, nor were the symptoms of increased intracranial pressure prominent; the clinical picture resembled septicæmia. Death occurred on June 25, 1919.

The autopsy revealed a large abscess in the left occipital lobe communicating with the ventricle and a metallic foreign body firmly encapsulated in the left cerebral peduncle entirely removed from the abscess cavity (Figs. 21 and 22). The endocardium was the seat of recent inflammatory changes, and

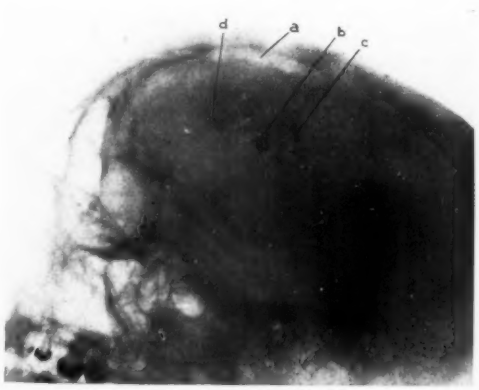

Fig. 23. Case 9. *a*, Skull defect at site of gunshot wound. *b* and *c*, Shell fragments deep in the cerebral tissue. *d*, Bone fragment shadow deep in the cerebral tissue.

Fig. 24. Case 9. Anteroposterior view of Figure 23. The letter indications are the same.

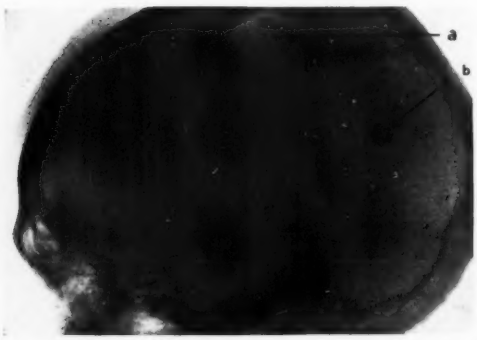

Fig. 25. Case 10. *a*, Small skull defect, the point of entrance of a pistol bullet 10 years previous. *b*, Thirty-two caliber bullet deep in the substance of the occipital lobe, not causing symptoms.

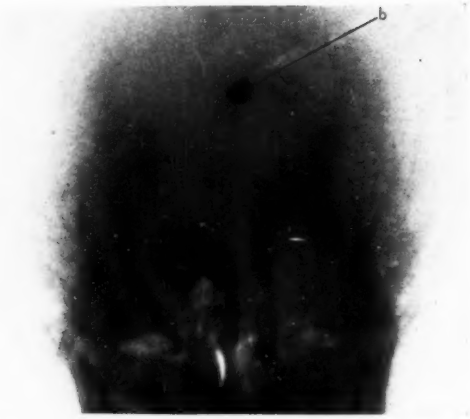

Fig. 26. Case 10. Anteroposterior view of Figure 25.

cultures from it showed streptococcus hæmolyticus. Cultures from other organs also showed the same growth.

The condition of the patient before the first operation, June 5, 1919, indicated the presence of an abscess in the left occipital lobe, which was causing moderate disturbance. The operative manipulation is believed to have excited the dormant streptococcus hæmolyticus, resulting in an increase in the size of the abscess, general septicæmia, and the death of the patient.

Fig. 27. *a*, Jacket of fragmented bullet removed from Case 6. *b*, Distal portion of steel core removed from Case 6. *c* and *d*, Shell fragments removed from right parietal lobe of Case 7. *e*, Small shell fragment removed from left temporal lobe in Case 4. *f*, Machine-gun bullet removed from right cerebellar hemisphere in Case 1. *g*, Shell fragment removed from left temporal lobe in Case 2. *h*, Shell fragment removed from left frontal lobe in Case 5. *i*, Shell fragment removed from right frontal lobe in Case 3.

This case should perhaps have been classified with the inflammatory cases, of which we hope to write later, since there was no attempt made to remove the metal. It is included, however, with this group since it so well illustrates the relative seriousness of bony and metallic foreign bodies in the brain. The postoperative course was certainly unusual in that the symptoms suddenly changed from those of increased intracranial pressure, with subnormal temperature and pulse-rate to high temperature and very rapid pulse. The condition was not well understood until the autopsy, when blood cultures from various organs, including the heart, gave streptococcus growth.

CASE 9. Pvt. R. H. S. Gunshot wound in left frontal region; metallic foreign body deep in the left frontal lobe; no symptoms; no operation; recovery.

The patient was injured November 9, 1918, by a bursting shell. Several pieces of metal and bone were removed at one of the forward hospitals.

When he was examined at U. S. General Hospital No. 2., Fort McHenry, Maryland, there were no neurological symptoms, and the general condition of the patient was good. Roentgenograms revealed a bony defect in the left frontal region and two metallic foreign bodies (Figs. 23 and 24). The defect in the left frontal region was the seat of marked pulsations, which caused the patient to desire that the foreign bodies be removed and the skull repaired.

Because of the absence of serious symptoms and the fact that the bodies were not large, but deeply placed in the brain substance, their removal was not attempted. The patient was discharged from the army, with instructions to report later.

CASE 10. Civilian J. L. Pistol bullet in left hemisphere 10 years; no symptoms; no operation.

In 1909 the patient was injured by a thirty-two caliber pistol bullet. Immediately following the injury there was only slight neurological disturbance and it was decided not to remove the missile. Since the injury the patient has suffered no ill effects, but presented himself for examination with the intention of leaving the bullet undisturbed if it were advisable. A roentgenogram revealed a small skull defect (Fig. 25) and the bullet shadow (Figs. 25 and 26). This case again illustrates the fact that metallic foreign bodies in the absence of infection are well tolerated in the brain tissue.

The postoperative roentgen-rays have not been included, but the foreign bodies removed may be seen in Figure 27.

The end-results of the cases may be summed up as follows:

Case 1 — complete recovery;

Case 2 — complete recovery with the exception of dim vision of the right eye, due to direct injury at the time of the accident;

Case 3 — persistence of headache, which has made it necessary to defer repairing the skull defect;

Case 4 — complete recovery;

Case 5 — complete recovery, with repair of the skull defect;

Case 6 — death, the result of infection due to the disturbance of dormant organisms in the scar tissue surrounding a cyst in the frontal lobe, which communicated with the ventricle;

Case 7 — recovery, with marked degree of hemiplegia of the opposite side, which is gradually improving;

Case 8 — death, the result of streptococcus hæmolyticus septicæmia, which was due to the stirring up of dormant organisms in the left occipital lobe;

Case 9 — no operation, because of the inaccessibility of the metal and the absence of symptoms, discharge from the army in good condition;

Case 10 — no operation, since there were no symptoms after a period of ten years.

This report has been made possible through the cooperation of the various departments of the U. S. General Hospital No. 2, Fort McHenry, Maryland; and through the personal assistance of Lieutenant-Colonel T. J. Leary, the chief of the surgical service, Major J. F. Lutz, in charge of the roentgen-ray department, and Lieutenant M. J. Egan, assistant in the neurosurgical service.

REDUCTION OF OLD DISLOCATIONS OF THE HIP BY OPEN INCISION[1]

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THE exact time at which an unreduced dislocation of the hip becomes old cannot be definitely stated. If the possibility of reduction by external means be made the criterion, the period, for practical purposes, is too long, because reduction by manipulation or force has been accomplished in some cases many months after dislocation has occurred.

Reports of such cases, however, should not be accepted without close scrutiny, as investigations have shown that the records of many cases before the invention of the X-ray were of doubtful value.

Sir Astley Cooper's opinion was that, after 8 weeks, it would be imprudent to attempt reduction of a hip dislocation. A better standard is the pathological condition present and this is capable of more exact investigation, in the light of animal experiments and operations performed on human beings in recent years. Such operations show that as early as 4 to 6 weeks the acetabulum is filled with shreds of capsule and newly formed connective tissue and the head fixed in its false position by tissue of the same kind.

Experiments[2] on dogs have shown that, 14 days after dislocation, soft, newly-formed tissue usually fills the acetabulum. This tissue is much firmer in 3 or 4 weeks, and 8 or 10 weeks after the dislocation the mass becomes so hard that replacement is impossible without clearance of the cavity. It is true that these obstacles do not in all cases preclude reduction; but they furnish important reasons for its usual lack of success.

For the purposes of this paper, and because a definite time limit must here be placed, beyond which cases operated upon are considered old, 4 weeks has been decided on, earlier cases being considered recent.

Attempts at reduction by external manipulation and by forced traction have from the earliest times to the present, been occasionally attended by disastrous results, such as fatal hæmorrhage from rupture of the great vessels and fracture of the neck or shaft of the femur. These accidents have been reported with sufficient frequency to bring manipulation and power traction into disrepute and to give rise, since the era of antisepsis, to the belief that open operation is much to be preferred.

The first attempt to effect reduction by open operation was by Delagarde in 1861.[3] In his case, the original injury occurred 5 months before and was complicated by a double fracture of the same femur which had subsequently united. The head lay in the sacrosciatic notch and caused intolerable pressure on the sciatic nerve. The head could not be restored to the socket and was, therefore, excised. The patient was relieved both of his pain and disability.

The pathological anatomy of these cases was studied in the middle of the last century, notably by Malgaigne and Tillaux, who demonstrated on the cadaver the pathology which has since been found so uniformly in cases operated upon. Fortified by this knowledge and encouraged by the measurable success at the time of the Listerian system, a few attempts at open reduction were made in the late seventies, all of which failed and ended in resection of the head of the femur with correction of the position of the limb so as to bring the stump of the neck near to or into the acetabulum.

In 1882, the first actual reposition of the head into the acetabular cavity was made by Polaillon. Unfortunately the patient died of gas bacillus infection on the fourth day. Since that time, there have been found in literature reports of 47 additional operations. To these may be added a case, not hitherto reported, in the practice of O. C. Gaub, of Pittsburgh, and the writer's case herein detailed, making 50 in all.

The first operations in this country were performed by the late Charles T. Parkes, of Chicago, and reported by A. J. Ochsner, his

[2] Volkmann. Deutsche Ztschr. f. Chir., 1893-4, xxxvii, 373.

[3] St. Bartholomew's Hosp. Rep., 1866, ii, 183.

[1] Read before American Surgical Association, May 5, 1920.

assistant. He not only secured excellent results in his 2 cases, but also showed the value of levers placed under the neck to lift the head back into its socket.

The only complete paper on this subject hitherto published in the English language was contributed to the *Annals of Surgery*, in 1894, by M. L. Harris, of Chicago. His operation was a success, and his paper is now a classic.

It has been possible for the author to secure from the literature 48 cases, which, with Dr. Gaub's and his own make up the 50 cases which are briefly reported below.

Analysis of these cases will show that, while open reduction in old hip luxations is usually difficult and not altogether devoid of danger, it is the operation of choice. In a very large proportion of cases, it greatly improves the use of the limb and, in very many, restores its complete function. Where reduction is impossible, resection of the head may still be done to secure improved position of the limb. This operation, however, has a higher mortality and is followed by less perfect use.

ANALYSIS OF 50 CASES REPORTED

If assorted into decades, it will be found that 3 open reductions were made in the eighties, 21 in the nineties, 20 in the first decade of the present century, and only 6 reported in the last ten years. The reason for the small number of cases reported in recent years is probably the general use of the X-ray, which has rendered this diagnosis easy even to those not skilled in surgery.

By countries, it may be said that 13 of these patients were operated upon in the United States, 6 in France, 6 in Great Britain, 3 in Italy, 1 in Switzerland, 14 in Germany and 7 in Austria.

Sex and age. There were 41 males, 8 females, and in 1 case the sex was not stated.

There were:

	Cases
In first decade of life	12
In second decade of life	12
In third decade of life	6
In fourth decade of life	9
In fifth decade of life	6
Above the 50th year	3
"Adult"	1
Not stated	1
Total	50

This incidence of sex and age is not markedly different from that which obtains in large collections of recent dislocations. The chief difference is in the greater number of cases in little children whose dislocations if neglected are more amenable to reduction than those of adults and whose operations are less likely to terminate in resection of the head.

DURATION OF DISLOCATION

	Cases
1 to 2 months	13
2 to 3 months	12
3 to 4 months	5
4 to 5 months	7
5 to 6 months	1
6 months to 1 year	8
1 to 4 years	3
16 years	1
Total	50

EARLY TRIALS AT REDUCTION

	Cases
Fruitless efforts immediately after dislocation	11
No early trials made	17
No record of early trials	17
Trials made within first 4 weeks	4
Previously reduced by operation	1
Total	50

FORM OF DISLOCATION

	Cases
Dorsal	34
Obturator	10
Sciatic	3
Upward	2
Not stated	1
Total	50

PATHOLOGICAL CONDITION PRESENT

	Cases
Acetabulum said to have been filled with connective tissue in	38
Acetabulum said to have been empty in	1
Head and neck said to have been bound down by fibrous tissue in	11
Cartilage said to have been intact in	12
Rim of acetabulum said to have been broken in	3
Fracture of cup of acetabulum reported in	3
Fracture of pelvis in	2
Head pushed through obturator membrane in	1
Epiphyseal separation in	1

OPERATIVE TECHNIQUE

Incision. In 32 cases in which the location of the incision was definitely stated, there were done by

	Cases
Langenbeck's straight incision	11
Barker's anterior incision	8
Kocher's angular incision	7
White's posterior incision	2
Combined anterior and posterior incision	3
Goblet incision	1

Preliminaries to reduction. In 4 cases the trochanter was chiseled through at the base, and after reduction had been accomplished, fixed back into place, once with screws and 3 times with silver wire. In 11 cases all muscular attachments were separated from the great trochanter, usually subperiosteally. In 30 cases, it was noted, that the acetabulum was emptied of its connective-tissue filling with scissors, knife, or curette. In one case it was said to be empty. In one case the acetabular content was not removed, and, in it, recurrence of the dislocation took place. Tenotomy of the adductors was resorted to in one case, and the chiseling of the rim of the acetabulum in another.

Reduction. The method of reduction is stated in a minority of the cases only. In 13 cases it was by manipulation; in 3 by levers and manipulation; and 2 by strong hooks; and in 1 by pulleys. Reduction is said to have been easy in 9 cases and difficult in 8; in the remainder of the cases no statement is made on this point, but, from the description of the operation, it would seem to have been difficult.

After-treatment. Most of the patients were treated by extension, abduction, and external rotation, maintained by weight and pulley with side splint or by a plaster-of-Paris dressing.

Mortality. Only 3 patients died (6 per cent): (1) case of Polaillon, in 1882, died on the fourth day from gas gangrene; (2) case of Mikulicz, in 1895, died in 6 weeks, from sepsis with pelvic infiltration; (3) case of De Forest Willard, published in 1904, died in one week, from septic endocarditis.

FUNCTIONAL RESULT OF OPERATIONS

Of the 45 cases reported, 36 (80 per cent) had good results and 9 (20 per cent) had moderate improvement or poor results as follows:

	Cases
Perfect result	8
Excellent result	9
Good result	2
Great improvement	1
Considerable improvement	2
Good function but limited motion	8
Good function, but hip ankylosed	4
Greatly improved, but ankylosed	1
Early report, but very promising	1
Total	36
Some improvement, but ankylosed	2
Slight improvement	2
Poor function; hip ankylosed	2
Very poor result	2
Recurrence (re-operated upon)	1
Total	9
No report	2
Dead	3
Total	50

Of the 9 cases in which the operation could not be considered successful, one was performed on a girl of 12, for a luxation of 3 years' standing; one on a child of 10, for a luxation of 2½ years' standing; in 2 cases the suppurating head required excision some months later and in 1 there was long-continued suppuration with peroneal paralysis.

Author's case. The young man whose case furnished the motive for this paper is 19 years old, a machinist by trade. He was injured September 20, 1918.

An automobile in which he was riding was struck by a train and "turned turtle." The patient was found pinned under it, unconscious. He was taken to a hospital in a neighboring town where he remained unconscious for 10 days, probably from cerebral concussion. A diagnosis of fracture of the pelvis was made, which later X-ray plates confirmed, and he was kept in bed for 9 weeks with Buck's extension on the limb. He remained in the hospital 3 months when he was dismissed and taken to his home. He remained at home 6 weeks and then returned to the same hospital and had X-ray plates taken, after which an anæsthetic was given and manipulation of the limb used with no evident result. Two weeks later (February 21, 1919) he came to Mercy Hospital, Pittsburgh, on crutches, which he had been obliged to use constantly ever since he was allowed out of bed.

Physical examination showed the usual signs of backward dislocation of the hip; shortening (1¼ inches), inversion, adduction. There was, however, but slight flexion. The head could be felt to roll under the fingers in the ordinary place of a dorsal dislocation. He could not bear weight on the limb, owing to the sliding upward of the head on the dorsum of the ilium.

X-ray plates were made on February 28, which showed a dorsal dislocation of the hip with a nearly transverse fracture at the junction of the shaft with the neck. The outline of the pelvis near the acetabulum was indistinct as though from a fracture. The fracture of the femur had united in good position.

The patient was put to bed with Buck's extension, the traction being applied to the thigh only. After prolonged use of traction with heavy weights the

most that could be gained was one-half inch additional length. Operation was decided on, and preparation for efficient traction and manipulation at time of operation was made 3 days before the time set.

This consisted in the application of a strip of adhesive plaster of triple thickness applied to each side of the thigh, each strip having fixed in its lower end a harness ring as shown in the drawing.

Operation was performed on April 19, 1919. A Kocher incision was used. Towels were fixed to the wound edges to protect from skin infection. The incision was deepened until the margin of the acetabulum could be exposed. This cavity was roofed over and filled with dense connective tissue and shreds of capsule.

All this tissue was dissected out with strong scissors, exposing the normal cartilage. The fibrous tissue was then lifted and cleared from the anterior aspect of the great trochanter and neck until the cartilaginous margin of the head was reached. The pelvis was firmly fixed to the table by a band of webbing passing over it; the lower leaf of the table was dropped permitting the patient's right knee to be flexed and the leg to hang.

The webbing surcingle was then adjusted to the assistant, H. G. Kuehner, passing over his left shoulder, diagonally across his back and under his right axilla, each end being furnished with a harness snap which snapped into its corresponding harness ring above the patient's knee. The surcingle had by previous trial been adjusted to the proper length. Dr. Kuehner then passed his right forearm under the patient's left flexed knee and, by standing on a low stool with his right foot and placing his left knee against the table, was able to exert the most powerful traction, using both his arm as a hook and the weight of his body as a tractive force. He was able to change the direction and force of his pull at will, using any angle of flexion, adduction, abduction or rotation, according to the varying requirements of the operator.

So firmly were the head and neck entrenched in their bed of connective tissue that they could not be delivered until this tissue was cut away by the use of curved scissors passed behind the bone. Four levers were then passed under the neck, and, by their use together with the efficient manipulation and traction of Dr. Kuehner, the head was delivered to the margin of the acetabulum and then into its cavity.

The return of the head to its socket was marked by the characteristic click which indicates the reduction of hip luxation. This click could be heard across the room. After the head was in place, there seemed to be no disposition for it to leave the socket. The external branch of the Y ligament remained intact, but the internal branch had been separated.

The cavity left by replacement of the head was drained with a cigarette drain and rubber tube, and the remainder of the incision closed with buried sutures of catgut and superficial ones of silk.

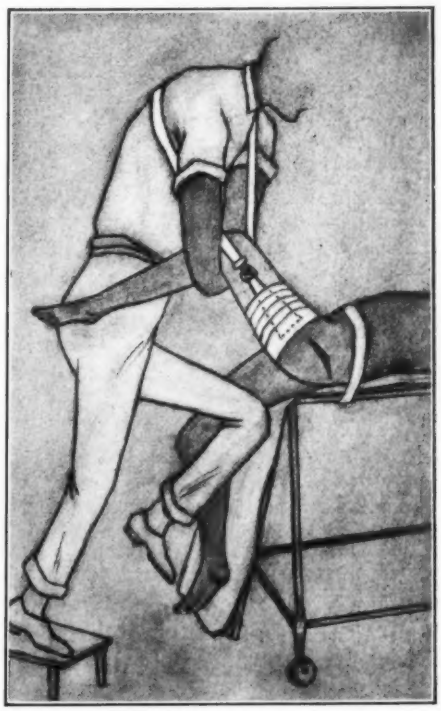

Fig. 1. Reduction by body traction.

Toward the close of the operation the patient's pulse became weak and rapid, due probably to shock from the forcible manipulations and loss of blood caused by the dissection of the bone from its bed. The hæmorrhage was not great and was entirely from small vessels. Later in the day he had quite an active oozing which required removal of stitches and packing of the cavity with gauze. The effect of this loss of blood was very marked and passed off only after administration of salt solution by hypodermoclysis.

The limb was fixed in abduction to a long splint with slight traction and the pelvis kept from tilting by applying a Buck's extension to the other limb in strong abduction.

After operation foot-drop was noticed which persisted for several months, but finally disappeared. It was thought to have been caused by pressure on the sciatic nerve by the levers or more likely by traction on the external popliteal at the bend of the knee.

A tendency to eversion of the limb persisted, due to loss of the internal branch of the Y ligament. The pit, which had been packed with iodoform gauze, rapidly filled with healthy granulations and healing proceeded in an orderly manner.

In 7 weeks he was fitted with a brace which reached from the brim of his pelvis to his shoe.

In 8 weeks he walked about the ward, bearing weight on his limb, a partial peroneal paralysis persisting.

In 10 weeks he was dismissed from the hospital, a plate taken at that time showing the head of the bone in its socket.

He returned for examination on September 16 (almost 5 months after operation), still wearing the brace by day and carrying a cane. There was no shortening, but still some eversion. Two weeks later he discarded the brace.

He came back 6½ months after operation and then for the first time a shortening of ½ to ¾ inch could be demonstrated. The peroneal paralysis had disappeared and the patient walked with comfort.

On March 18 (11 months after operation), he was examined for the last time and the shortening was 1⅛ inches, abduction 25° and flexion at the hip 35°. He walks with a solid gait and without pain and has for some months been working as an automobile repairman.

Preliminary traction with Buck's extension is of great service, the adhesive plasters being invariably attached to the thigh only, never below the knee, in order to obviate injurious lengthening of the ligaments of the joint. The effect of this traction is to draw the head of the femur more nearly to the level of the acetabulum, and not only to lengthen the connective-tissue bands which bind down the neck, but to stretch the shortened pelviofemoral muscles.

The occasional use of passive movements of the limb at the hip and knee also serves the purpose of breaking up recent and stretching old adhesions.

The question of whether to attempt reduction by external means (manipulation and traction) is very important and must be decided in each case on its own merits.

Those, like Poncet and many other eminent surgeons, who have had fatalities after the most careful efforts at reposition, are strongly of the opinion that the hidden danger is the one most to be feared, and that, after a hip dislocation has become ancient, the only safety lies in the open way.

This, also, is the opinion of those who have operated on such cases by open reduction, and have seen the acetabulum filled with connective tissue and roofed over with shreds of capsule, and the head and neck bound down with a dense fibrous growth. These latter have usually experienced great difficulty in the return of the head to its socket, even after complete dissection has been made.

On two points there will be general agreement: first, that if efforts by the so-called bloodless method are made, the most extreme care should be taken to avoid undue violence; and, second, that an interval of a number of days should elapse between the failure of such an attempt and the performance of the bloody intervention.

CONCLUSIONS

1. Traumatic hip dislocations may be considered old at the end of 4 weeks.

2. Reduction by manipulation is rarely successful after that time, owing to formation of connective tissue, which fills the acetabulum and binds down the head and neck.

3. Reduction by open incision is to be preferred in nearly all cases of old hip luxations and with modern methods is attended with but little danger.

4. Preliminary traction by Buck's extension is of advantage.

5. The actual replacement of the head, after the acetabulum has been emptied and the head and neck released, is best accomplished by manipulation or the use of levers with manual and body traction (Fig. 1).

6. The result is often ideal and, in the cases reported, has been good in 80 per cent.

REPORT OF CASES

CASE 1. December, 1882. Operated upon by Polaillon; reported in Bull. Soc. de chir., Par., 1883, Jan. 31, p. 110. Male, age 46, had suffered for 6 weeks from dislocation of the hip, following a fall from a wagon. Attempts had been made to reduce the dislocation on the second, eighth, thirteenth, and twenty-first days. The patient presented the usual condition of dorsal luxation. Dorsal luxation converted into thyroid dislocation. Thick layers of connective tissue, probably shreds of capsule, covered the acetabulum and head. An anterior vertical incision was made and the head and neck completely isolated. The patient died on the fourth day from gas gangrene.

CASE 2. 1887. Operated upon by Vecelli, Venice; reported in Arch. d'orthop., 1887; also Rev. d'orthop., 1890. Female adult, had suffered 40 days from double dorsal and right obturator dislocations, the result of having been buried under a fallen wall. Posterior incision. Tenotomy was performed and the dislocation easily reduced. The obturator luxation was not operated upon. The patient recovered without complications and gait is satisfactory.

CASE 3. May, 1888. Operated upon by Charles T. Parkes, North Am. Pract., Chicago, 1890, ii. 499. Male, age 21, suffered for one year from dorsal dislocation of the

hip, caused from being buried under a fall of coal. Unsuccessful efforts were made to reduce the dislocation soon after injury. The patient limped and suffered great pain on walking. There was a slight fracture of the acetabulum, the cartilage of the acetabulum and head were intact, the acetabulum was empty. A vertical incision was made over the trochanter, the tronchanter freed of its muscles, and the head easily pried into place with a lever. The patient recovered from operation. Extension was applied for 8 weeks. There was slight suppuration but the patient recovered in 11 weeks. Movement of the limb is limited but the patient walks without pain or lameness.

CASE 4. November, 1889. Operated upon by Riedel, Jena; Arch. f. klin Chir., 1898, lvi. Male, age 5. Six weeks ago the patient was caught in a wagon wheel, producing a dorsal dislocation of the hip. No efforts were made to reduce the dislocation. The cartilages were intact. Through a Langenbeck incision the trochanter was freed, the dislocation reduced, and the wound closed without sutures or drain. The patient recovered. Extension was applied. There was motion in narcosis in 4½ months. Two years later, the patient showed an ideal result with all movements.

CASE 5. June, 1890. Operated upon by Charles T. Parkes, Chicago, N. Am. Pract., Chicago, 1890, ii, 499. Male, age 30. Five months ago the patient was struck on the hip by a sack of wheat which had fallen 12 feet, producing a sciatic dislocation. Immediate attempts at reduction was thought to be successful. Prior to operation the patient walked with a marked limp and suffered great pain. Examination showed the acetabulum filled with granulations, the cartilage intact. A vertical incision was made over the trochanter and then a curved incision forward. The neck and trochanter were freed. Reduction was accomplished with difficulty. The patient recovered from operation. Extension was applied for 10 weeks. The patient walked with crutches in 14 weeks. Although the patient was much shocked from operation and suffered a slight infection, he recovered in 14 weeks. The attitude is normal and the patient has good motion.

CASE 6. June, 1890. Operated upon by Duret; reported in F. Dennetière's article, in Thèse de doct., Par., 1890. Female, age 12, had a dorsal dislocation of the hip received 3 years ago as the result of a fall, striking the hip. No attempts had been made to reduce the dislocation. Examination before operation showed atrophy and 7 centimeters shortening of the limb. The acetabulum was full of fibrous tissue. An incision made over the trochanter, tenotomy of adductor muscles. The patient recovered, an extension bandage was applied, there was no suppuration. There was still a shortening of 4 centimeters, the movements were more extensive than before, but limited.

CASE 7. Operated upon by Kirmisson; reported in Soc. de chir., 1892, Mar. Male, age 19, had a dorsal dislocation of 4 years' standing. Before operation there was a shortening of 6 centimeters. Through a lateral incision, part of the head was removed, the rest replaced. The patient recovered. There was some suppuration. After operation there was still 6 centimeters shortening, position was improved, mobility was sufficient. The patient walks easily with an elevated sole.

CASE 8. September, 1892. Operated upon by Kuester, Marburg; reported in article by Rudolf Volkmann, Deutsche Ztschr. f. Chir., 1893, xxxvii, 373. Male, age 9, 7 weeks ago suffered dorsal dislocation of the hip, the result of a fall from a tree. No attempts were made to reduce the dislocation until 3 days before operation. Before operation there was 5 centimeters shortening and the patient walked with difficulty, with crutches. Examination showed the head bound down, the acetabulum full, round ligament present, cartilages intact on head but lost in acetabulum. Through a Langenbeck incision, the acetabulum was excavated; the head and trochanter freed. Replacement was accomplished without much difficulty. The patient recovered. Extension in abduction was applied, later inversion with adhesive plaster. Primary union resulted but there was a tendency to reluxation. The patient remained in bed 2 months. The result was ideal; full return of function when seen one year after operation.

CASE 9. December, 1892. Operated upon by Arpad Gerster, New York; reported in Ann. Surg., 1893, xvii, 586. Male, age 8, 7 weeks ago was run over by an express wagon causing a dorsal dislocation. No attempts had been made to reduce the dislocation. Before operation the patient was unable to walk. He had paralysis of the anterior tibial group of muscles, and 1⅝ inch shortening of the limb. The head was covered with granulations and the acetabulum was almost filled with them. A five-inch incision was made with center at great trochanter. Section of part of Y ligament. The head was easily replaced by manipulation. The patient recovered. Extension with abduction was applied; no brace was used after the patient left his bed. Convalescence was smooth, the patient was out of bed in 3 weeks, and left the hospital in 2 months, walking with a cane, but with paralysis of anterior tibial group. Dislocation recurred soon after leaving the hospital, without trauma.

CASE 10. May, 1893. Operated upon by V. P. Gibney, New York; reported in Ann. Surg., 1894, xx, 621. Male, age 8, 7 months ago was run over by an express wagon and suffered a dorsal dislocation of the hip. Seven weeks after injury reduction was attempted through open incision. The dislocation recurred and the patient suffered from paralysis and shortening. The acetabulum was filled with fibrous tissue. An incision was made through the scar of former operation and the acetabulum was curetted with sharp spoon, the adductors were divided, and the head reduced with great difficulty. The patient recovered. A fixed dressing of plaster of Paris was applied, with the limb in abduction. Suppuration persisted for some time but the wound finally closed. Five months later the head was still in place, although foot-drop persisted and the hip was quite stiff.

CASE 11. 1894. Operated upon by W. G. Spencer, London; reported in Tr. Clin. Soc., Lond., 1895, xxviii, 293. Male, age 7, 5 months ago fell from a roller which passed over the legs, producing a dorsal dislocation. Immediate efforts were made to reduce the dislocation which were thought to be successful. The patient was very lame. The acetabulum was found to be filled with dense fibrous tissue. Through a straight anterior incision the acetabulum was cleared out. The patient recovered. The limb was fixed in a plaster splint in position of abduction and external rotation. Following operation there was fibrous rigidity with slight abduction and rotation but the prognosis was good.

CASE 12. February 11, 1894. Operated upon by M. L. Harris, Chicago; reported in Ann. Surg., 1894, xx, 319. Male, age 33, 4 months ago was struck on hip by a 350-pound pulley, and suffered a dorsal dislocation. Three attempts at 4, 5, and 7 weeks after the accident were made to reduce the dislocation. Before operation, the limb was atrophied and useless. Examination showed the acetabulum filled with tough connective tissue and capsule, the cartilage smooth, the head on the posterior superior edge of the acetabulum, and a small piece broken from the rim of the acetabulum. An incision was made between the tensor vaginæ femoris and the gluteus medius. All muscles attached to the great trochanter and shaft as far as the lesser trochanter were severed subperiosteally.

The acetabulum was cleared with a sharp spoon. The head was replaced with difficulty by manipulation. The limb was encased in a plaster cast, in extension, abduction, and external rotation. The patient recovered from operation but suffered from considerable shock at first. He walked about on crutches in 6 weeks. In 3 months he walked well with a cane. Motion was limited but was increasing.

CASE 13. October, 1894. Operated upon by Riedel, Jena; reported in article by Endlich, Arch. f. klin. Chir., 1898, lvi. Male, age 9, was run over 10 weeks ago by a wagon and suffered an obturator dislocation. No attempts were made to reduce the dislocation. Before operation the patient had no motion and walked badly. Examination showed the acetabulum full, the head normal. Through an antero-external incision reduction was easy. The wound was not closed. A lateral splint was applied. The patient recovered from operation. There was suppuration and sequestra were eliminated. There was some ankylosis in slight flexion, there was no shortening, and gait was good.

CASE 14. May, 1895. Operated upon by Mikulicz, Breslau; reported in article by Drehmann, Beitr. f. klin. Chir., 1896, xvii. Female, age 36, was run over by a sled, 18 weeks ago, and suffered an ischiatic dislocation. Unsuccessful efforts were made to reduce the dislocation 2 weeks after injury. Before operation the limb was useless. Examination showed much scartissue, the acetabulum filled. A "snuff-box" incision was made, osteotomy of the trochanter performed, and the acetabulum evacuated. A plaster splint with inward rotation was applied and in 6 weeks a Taylor brace. The patient recovered from operation and the wound healed by primary union. Mobility was satisfactory and gait was normal after 4 months.

CASE 15. August, 1895. Operated upon by Riedel, Jena; reported in article by Endlich, Arch. f. klin. Chir., 1898, lvi. Male, age 37, 3 months ago suffered a blow from a falling tree, causing an obturator dislocation. The dislocation was not recognized for 7 weeks. The patient walked with a cane and crutch. Examination showed the acetabulum full, the head surrounded with bony shell. An antero-external incision was made, the acetabulum cleared, the rim of the acetabulum chiseled off to permit reduction. The patient recovered from operation and was out of bed in 4 weeks, wearing a Volkmann's splint. The wound discharged for some time. There is shortening of 1 centimeter, flexion to 35 degrees, but the patient walks easily for many hours.

CASE 16. October, 1895. Operated upon by Mikulicz, Breslau; reported in article by Drehmann, Beitr. f. klin. Chir., 1896, xvii. Male, age 8, fell 10 weeks ago, causing a dorsal dislocation. Immediate efforts were made to reduce the dislocation but without success. The patient was very lame. Examination showed the acetabulum full, the epiphysis loose, the head tightly fixed. A transverse vertical incision was made, the acetabulum evacuated, the trochanter chiseled off, the dislocation reduced by manipulation, and the trochanter sutured. The limb was placed in a splint in extension and outward rotation. The patient recovered from operation, the wound healing by primary union. The patient walked well in 6 weeks and left the hospital in 2½ months.

CASE 17. November, 1895. Operated upon by Mikulicz, Breslau; reported in article by Drehmann, Beitr. f. klin. Chir., 1896, xvii. Male, age 41, was injured 20 weeks ago by a wagon overturning and falling upon him, causing an ischiatic dislocation. Immediate efforts were made to reduce the dislocation which were thought to be successful, but the patient was very lame. Examination showed the head firmly bound and in the acetabulum a fibrous mass and fragments of bone. A bow-shaped incision was made, the trochanter chiseled off, the acetabulum evacuated. Reduction was by manipulation easily accomplished, and the trochanter sutured. The limb was placed in extension in outward rotation. The patient suffered septic infection with secondary luxation and pelvic infiltration from which he died in 6 weeks.

CASE 18. August, 1896. Operated upon by Emma S. Merritt, San Francisco; reported in Phil. M. J., 1898, ii, 386, article by Sherman. Male, age 9, fell into a well one year ago, causing a dorsal dislocation of the hip. No efforts at reduction are recorded. Before operation the patient could get about but was much disabled. Examination showed the head fixed by fibrous tissue and the acetabulum filled with it. An incision was made along the posterior border of the tensor vaginæ femoris, the head was released, the acetabulum cleared with a sharp spoon, and reduction accomplished with difficulty. A double spica plaster-of-Paris was applied. The patient recovered from operation, convalescence was stormy. The joint was stiff when last seen, limp was present, but the limb was useful.

CASE 19. Operated upon by Bergmann, Berlin; reported by Engel, Arch. f. klin. Chir., 1897, lv, 629. Female, age 48, fell from a sled 7½ weeks ago, causing a dorsal dislocation. The patient walks only with crutches. Examination showed the cartilages intact, the capsule thickened. Through a Langenbeck incision, the trochanter and neck were freed and reduction accomplished by manipulation. A plaster-of-Paris dressing was applied. Because of abundant secretion, the stitches were removed and the wound packed. The patient recovered from operation and in 10 weeks walked with cane. The limb was in slight flexion.

CASE 20. Operated upon by Bergmann, Berlin; reported by Engel, Arch. f. klin. Chir., 1897, lv, 629. Male, age 18, fell from a horse 5¼ months ago, suffering a dorsal dislocation of the hip. He could not walk without crutches. Examination showed the acetabulum full, the cartilage eroded. Through a Langenbeck incision, the acetabulum was scooped out, the head freed from connective tissue, and a tampon placed in wound. The limb was placed in extension. The patient recovered from operation. There was some suppuration. In 73 days there were movements, the patient walked without cane or limp, the limb was in slight flexion.

CASE 21. June, 1897. Operated upon by Kaufmann, Zurich; reported by Hoefliger, Thésis de doct., Berne, 1900. Female, age 5¼, was struck 4 months ago by a falling roof, and suffered a dorsal dislocation of the hip, which was thought to have been reduced just after injury. The patient limped badly, the subtrochanteric fracture was united. Examination showed the head and neck bound down by fibrous tissue. A curved incision was made over the trochanter. An extension apparatus was applied. The patient recovered. There was some suppuration and sequestra were eliminated. Two years later the patient showed ankylosis, the limb was 2 centimeters short, and the patient walked without a cane.

CASE 22. November, 1897. Operated upon by Charles E. Bell; reported in Lancet, 1898, ii, 1059. Male, age 13, was injured 5 months ago while playing foot-ball and suffered a dorsal dislocation of the hip. No efforts made at reduction. The limb was absolutely useless. Examination showed the acetabulum filled with new tissue and remains of the capsule, the cartilage intact. Through an anterior incision, all muscles were separated from the bone subperiosteally as far as the lesser trochanter. The acetabulum was cleared with scissors and scoop. The head was returned by traction and manipulation. A long splint with weight was applied. The patient recovered and suf-

fered no shock from operation. The splint was removed in 2 months and he was allowed to use crutches. In 9 months he had perfect motion and could stand and walk well.

CASE 23. January 15, 1898. Operated upon by H. M. Sherman, San Francisco; reported in Phil. M. J., 1898, ii, 386. Female, age 4. Fell from a gate 7 months ago and suffered a dorsal dislocation of the hip. Efforts to reduce the dislocation were made at once and 6 weeks later. The patient was able to run about but carries herself in the position of iliac luxation. Examination showed the capsule torn from the femur and adherent in acetabulum, the cartilage intact. An incision was made along the posterior border of the tensor vaginæ femoris. The head was exposed and cleared. The glutei were cut from the trochanter, the acetabulum was cleared, and reduction easily accomplished. A plaster-of-Paris spica with the limb in abduction was applied. The patient recovered from operation, aseptic healing took place, the splint was removed on the nineteenth day. On the twenty-sixth day the patient walked with assistance. The child walked well and had free motion at 3 months.

CASE 24. 1899. Operated upon by Watson Cheyne; reported in Brit. M. J., 1899, ii, 1290. Male, age 60, fell 9 weeks ago, suffering dorsal dislocation of the hip. He was unable to stand alone before operation. Examination showed the acetabulum filled with soft tissue and fractured. The acetabulum was emptied, the patient recovered from operation and walked well in 2 months, without shortening.

CASE 25. 1899. Operated upon by Tietze, Breslau; reported in Jahresb. d. schles. Gesellsch., 1899, p. 89. Male, age 36, 12 weeks ago was struck by a rolling log and knocked down, causing a dorsal dislocation. Eight days after injury efforts were made in vain to reduce the injury. Examination showed the acetabulum filled. Longitudinal and transverse incision made, acetabulum excavated, reduction accomplished by manipulation, the wound sutured. A plaster-of-Paris dressing was applied and kept on for 6 weeks, with the limb in abduction. The patient recovered from operation and followed an aseptic course. In 7 weeks he walked without support. Although motion was limited the leg was strong.

CASE 26. Operated upon by Payr; reported in Deutsche Ztschr. f. Chir., 1900, lvii. One month ago patient suffered dorsal dislocation of the hip with fracture of the acetabulum. Through a Kocher incision, reduction was accomplished. Two-thirds of the wound was sewed, one-third tamponed. The patient recovered from operation. The limb was placed in extension. He was dismissed in 5 months. Motion was satisfactory, gait easy, but there was a slight limp.

CASE 27. Operated upon by Perrando; reported in Arch. di ortop., Milano, 1900. Male, age 10, 2½ years ago suffered a supracotyloid dislocation of the hip. Examination showed the acetabulum filled with dense connective tissue. Through an anterior longitudinal incision, the trochanter was freed, the acetabulum excavated, and the head modeled. The patient recovered from operation, there was slight suppuration, the end-results fair.

CASE 28. November, 1900. Operated upon by Dollinger, Budapest; reported in Ergebn. d. Chir. u. Orthop., 1911, iii, 83. Male, age 32, 4 weeks ago fell from a tree suffering a dorsal dislocation. Examination showed the acetabulum full of connective tissue and bony fragments. An anterior incision and partial incision of the Y ligament were made and the acetabulum cleared. A posterior incision was made and the head returned to position by pulley traction. Drainage with gypsum dressing applied. The patient recovered from operation. Although there was long continued suppuration, there was movement at the end of 6 weeks. Peroneal paralysis was present. Ten years later the peroneal paralysis persisted. The patient walked on the outer border of the foot and limped, and the hip was stiff.

CASE 29. April, 1901. Operated upon by Jacob; reported in Province méd., 1901, xv, 351. Male, age 24, fell into a hole in the road 3½ months ago, suffering a dorsal dislocation of the hip. Fruitless efforts to reduce the dislocation were made the next day. Before operation the patient could not walk. Examination showed the capsule adherent to the acetabulum which was filled with fibrous tissue. Through a Langenbeck incision the acetabulum was excavated, the head freed, and reduction accomplished. A small part of the head was removed. A splint was applied. The patient recovered from operation, and the wound healed *per primam*. Three months later there was no shortening, motion was almost normal, and there was no limp.

CASE 30. June, 1901. Operated upon by Haedke, Schivelbein, Pomerania; reported in Deutsche Ztschr. f. Chir., 1902, lxvi, 359. Male, age 14, 10 weeks ago suffered a dorsal dislocation of the hip, having been buried under a fall of earth from a wagon. No attempts at reduction made. Examination showed acetabulum filled with dense tissue and cartilage intact. Through a Kocher incision the muscles were separated from the trochanter and the acetabulum freed. Extension was applied for 4 weeks. The patient recovered from operation. The wound healed without suppuration and the patient was out of bed in 5½ weeks and had good motion. The result was ideal: there was no shortening.

CASE 31. October, 1901. Operated upon by Dollinger, Budapest; reported in Ergebn. d. Chir. u. Orthop., 1911, iii, 83. Male, age 33, injured under a fall of earth, 3 months ago, causing dorsal dislocation of hip. No efforts to reduce the dislocation recorded. Examination showed fragments of pelvis in the acetabulum through which there was a fracture. The patient recovered from operation. There was suppuration and the suppurating head was resected 2½ months later. Nine years later the patient limped badly, there was 8 centimeters of shortening, and flexion and adduction of limb.

CASE 32. January, 1902. Operated upon by Oberst, Halle; reported by Bruening, Deutsche Ztschr. f. Chir., 1904, lxii, 412. Male, age 40, 7½ weeks ago buried under fall of slack. He suffered a dorsal dislocation of the hip converted from obturator dislocation. No attempts had been made to reduce the dislocation until 4 weeks after injury. Examination showed the trochanter porotic, the ligamentum teres thickened, the acetabulum filled with fibrous tissue. Through a Langenbeck incision, the periosteum and muscles were separated from the trochanter. The head, neck, and trochanter were freed. The head was easily restored. Tamponade and secondary suture 8 days later. The patient recovered from operation. Passive motion was begun in 2 weeks. Healing was aseptic. There was no shortening. Ankylosis in extension 7 months later. The patient walks with a cane.

CASE 33. April, 1903. Operated upon by Lebeyrie, Nantes; reported in Gaz. méd. de Nantes, 1903, xxi, 560. Female, age 15, 4½ months ago fell while carrying a heavy weight on her shoulder and suffered an obturator dislocation. No attempts were made to reduce the dislocation. Examination showed the acetabulum filled with connective tissue and fragments of bone. Through a posterior incision of Langenbeck, the acetabulum was cleared. A plaster-of-Paris splint was applied with the limb in abduction. The patient recovered from operation. Healing progressed smoothly. The patient walks well but there is some limitation of motion.

CASE 34. Operated upon by De Forest Willard, Philadelphia; reported in J. Am. M. Ass., 1904, xliii, 881. Male, age 28, was injured 8 months ago, suffering a dorsal dislocation of the hip. Eight attempts were made to reduce the dislocation by as many surgeons. Before operation the hip was immovable and useless. Examination showed the acetabulum filled with tough fibrous tissue and the head was covered with it. Anterior and posterior incisions were made, and the acetabulum reamed out, the head cleared and reduced with great difficulty. The patient died in 7 days from septic endocarditis.

CASE 35. February, 1904. Operated upon by C. E. Thomson, Scranton, Pennsylvania; reported in J. Am. M. Ass., 1904, xliii, 884. Male. Eight months ago the patient was run over by a mine car. No efforts at that time were made to reduce dislocation. Leg amputation stump. Ten days before operation neck of bone had been fractured in an ineffectual effort at reduction by manipulation. Through anterior and posterior incisions, reduction was accomplished by means of long blunt hooks and the fracture nailed. The patient recovered.

CASE 36. June, 1904. Operated upon by Dollinger, Budapest; reported in Ergebn. d. Chir. u. Orthop., 1911, iii, 83. Male, age 48, 5 months ago suffered an obturator dislocation caused by a fall of earth. No attempts at reduction were recorded. Before operation the patient could not walk. Examination showed the acetabulum full of connective tissue and two small pieces of bone. There were strong cicatrices about the neck. The pyriformis obturator, and gemelli were cut. By manipulation the obturator dislocation was converted into an iliac dislocation and then reduced. The patient recovered from operation. There was some suppuration but this soon subsided. Examination 6⅓ years later showed complete ankylosis. The patient was very lame but had no pain.

CASE 37. November, 1905. Operated upon by Dollinger, Budapest; reported in Ergebn. d. Chir. u. Orthop., 1911, iii, 83. Male, age 26, fell downstairs 1 month ago and suffered dorsal dislocation of hip. No efforts were made at reduction. The patient could hardly walk. Examination showed a fracture of the pelvis, the acetabulum covered with thick connective tissue. The acetabulum was cleared and reduction of the dislocation accomplished by manipulation. Volkmann's apparatus for traction was applied. The patient recovered. The open method of treatment was employed, secondary sutures were applied and the patient walked on crutches in 23 days. The patient walks with normal gait, flexion is possible only to 140 degrees, there is slight adduction.

CASE 38. Reported by D. T. Taylor, Washington, North Carolina; reported in Charlotte, M. J., 1906, xxix, 282. Six weeks ago the patient suffered a dorsal dislocation of the hip. He was totally unable to walk or even to put the limb on the ground. Examination showed the acetabulum full. A straight incision was made over the trochanter. The muscular attachments to the trochanter were cut away. The acetabulum was cleared with a sharp spoon. The head was returned to position with great force, by manipulation. Slight extension was applied with weight and pulley. The patient recovered. Healing was good. The limb was in good position, and there was fair range of motion.

CASE 39. 1906. Operated upon by Aslett Baldwin; reported in West Lond. M. J., 1907, xii, 33. Female, age 18, fell 3½ months ago, suffering a dorsal dislocation of the hip. No attempt had been made to reduce the dislocation. The patient presented the typical signs of dorsal dislocation. Examination showed the acetabulum completely filled with new tissue and the head firmly fixed in its new location. Through an anterior incision traction and countertraction were applied, pressure was exerted on head, traction on neck with large hook. The patient recovered from operation. A Liston splint was worn 8 days, then sandbags and passive motion applied. The wound healed by primary union. Two and half months later, the movements were practically perfect.

CASE 40. February, 1907. Operated upon by Dollinger, Budapest; reported in Ergebn. d. Chir. u. Orthop., 1911, iii, 83. Male, age 22, was injured by a fall of earth 11 weeks ago and suffered an obturator dislocation. Examination showed the acetabulum full of fibrous tissue so fixed to cartilage that separation was impossible. At operation the acetabulum was reamed out, the head separated from its connective tissue attachments, the obturator dislocation converted into an iliac dislocation and reduced by manipulation. The patient recovered. There was suppuration and it was necessary to resect the head later. Three years and 8 months later there was fairly good motion, with 6 centimeters shortening.

CASE 41. February, 1907. Operated upon by Dollinger, Budapest, reported in Erbegn. d. Chir. u. Orthop., 1911, iii, 83. Male, age 8, 3½ months ago fell, causing a dorsal dislocation of the hip. No efforts were made at reduction. Before operation the patient walked with difficulty, using a cane. He suffered violent pain when he walked much. Examination showed the acetabulum filled with connective tissue. The acetabulum was emptied with scissors and knife. The dislocation was reduced by circumduction. The patient recovered. The limb was fixed in abduction in a plaster-of-Paris splint. There was superficial suppuration. The splint was removed and the patient walked in 30 days. He had perfectly normal function when seen 3½ years later.

CASE 42. March, 1907. Operated upon by Gilbert Barling, Birmingham, England; reported in Surg., Gynec. & Obst., 1908, vii, 566. Male, age 13, fell when sliding on ice, 5 weeks ago, causing an upward dislocation of the hip. No attempts had been made to reduce the dislocation. Examination showed stiffness, pain, and swelling of the joint, but the boy was able to get about. The head was found resting just above the rim of the acetabulum. The cavity was filled with thickened stump of ligamentum teres. Through an anterior incision partial section of the Y ligament was done and the acetabulum was cleared with scissors and curette. The patient recovered from operation. A box splint was worn for 23 days. The patient could walk without assistance in 6 weeks. The result was perfect, there was free motion and no lameness, 9 months later.

CASE 43. August, 1907. Operated upon by Streissler, Graz; reported in Beitr. z. klin. Chir., 1908, lviii, 571. Male, age 14, 11 weeks ago slipped and fell with his leg abducted, causing an obturator dislocation of the hip. Replacement was attempted 3 weeks after operation and again at 5 weeks, when fracture occurred at upper third. The patient walked painfully with cane. Examination showed the fracture at the upper third of the femur consolidated, the acetabulum full of connective tissue, the cartilages intact. Through a Kocher's incision, the acetabulum was cleared and reduction accomplished with levers. The wound was sutured in layers. The patient recovered from operation. The limb was fixed in abduction and extension. The wound healed by primary union, there was slight temporary displacement of the head which was later corrected. Two and a half months after operation the patient walked well without support, movements moderate.

CASE 44. January, 1908. Operated upon by Dollinger, Budapest; reported in Ergebn. d. Chir. u. Orthop., 1911, iii, 83. Male, age 52, 2¼ months ago was thrown down by fall of a tree, causing a dorsal dislocation of the hip. No

efforts were made at reducing the dislocation. The patient was very lame and peroneal paralysis was present. Examination showed the cartilage to be normal, the acetabulum filled with connective tissue, and there was fracture of the rim and cup of the acetabulum. The acetabulum was cleared at operation and replacement was easily accomplished by circumduction. The patient recovered. Drainage with gypsum dressing was applied. Healing was aseptic. The patient walked with crutches in 8 days and the plaster was removed in 8 weeks. One year and 8 months later the patient had very good function, but some limitation of motion. Slight peroneal paralysis was present.

CASE 45. May 10, 1912. Operated upon by A. Gibson; reported in Lancet, 1913, February 1. Male, age 49, 9 weeks ago was struck on the hip by a life-boat, causing a dorsal dislocation of the hip. No attempts were made at reduction. The patient presented the usual signs of dislocation with atrophy of the thigh muscles. Examination showed the head below obturator externus and the acetabulum almost obliterated by the adherent capsule. Through a Kocher incision, the obturator externus was cut, the trochanter separated at the base. The head protruded. The acetabulum was reamed out. The head was replaced with difficulty by leverage and manipulation. The trochanter was fixed with screws. The patient recovered from operation. He wore a Liston splint for 3 weeks. The limb was treated with massage. In 7 weeks he was allowed up and canes were discarded in 4 months. When patient was allowed up foot-drop was noted. The functional result was good but there was very little motion at hip when dismissed October 2.

CASE 46. July, 1914. Operated upon by Berard and Vignard; reported in Lyon méd., 1914, cxxii, 707. Male, age 31, 7 months ago fell from a ladder from which he hung suspended by his foot, causing an intrapelvic thyroid dislocation. Reduction was attempted first by a bonesetter and 3 months later by surgeons. The patient was unable to walk and the limb was atrophic. Examination showed the acetabulum filled with fibrocartilage and the head was pushed through the thyroid foramen. Through an anterior incision, the acetabulum was reamed out, the upper margin of the thyroid chiseled away, and the head reduced. The patient recovered from operation. The limb was fixed in abduction and slight flexion. Healing was slow due to the formation of large hæmatomata. Functional result; good position but some shortening and only 30 to 40 degrees of flexion.

CASE 47. January 24, 1916. Male, age 36, operated upon by J. B. Murphy, reported in Clinics of J. B. Murphy, 1916, v, 731. Male, age 36, fell from a wagon 16 years ago, suffering an obturator dislocation. Efforts to reduce the dislocation were made immediately after injury and one month later. Lordosis and scoliosis were present and the patient had pains and aches on prolonged standing or walking. At operation the head was found embedded in a dense mass of connective tissue and the capsule was not recognizable. Through a goblet incision, the external rotators were separated from the trochanter. The connective tissue was incised and the head easily replaced by manipulation. The patient recovered from operation. The limb was immobilized in "frog" position. The patient walked with crutches in 6 weeks. Functional result; very promising.

CASE 48. 1889. Operated upon by Parona. Male, age 51, suffered a dorsal dislocation of 2 months' standing. At operation the acetabulum was found filled. Through a Fiorani incision, reduction was accomplished with difficulty. The patient recovered from operation. There was some suppuration.

CASE 49. April, 1917. Operated upon by Gaub, Pittsburgh; personal communication. Male, age 35, was injured 3 months ago, rolled between railroad cars, receiving an anterior dislocation of the hip. No attempts had been made at reduction as the co-existing injuries caused the dislocation to be overlooked. The patient was bedridden by reason of other injuries—fracture of same femur, right humerus and left ilium. Examination showed a stellate fracture of the acetabulum which was filled with connective tissue. Through an anterior incision the acetabulum was cleared and reduction was accomplished with difficulty by means of traction and levers. The patient recovered. A plaster-of-Paris cast was applied extending to the nipple. Functional result was excellent; the patient now works as a conductor.

CASE 50. April, 1919. Operated upon by Buchanan, Pittsburgh; reported herein. Male, age 18, 7 months ago was crushed under a capsized automobile, suffering a dorsal dislocation of the hip. No attempts had been made at reduction. The patient was very lame and walked with difficulty with crutches. A fracture of the acetabulum and ununited subtrochanteric fracture were present, the acetabulum was full, and the head and neck were bound down. Through a Kocher incision, the acetabulum was cleared, the head and neck freed, and reduction was accomplished with difficulty, by manipulation and levers. The patient recovered from operation. A long splint was applied to produce traction in abduction and external rotation. Healing progressed smoothly. Function is good.

OBSERVATIONS ON CANCER OF THE RECTUM

By ERNEST A. WELLS, M.D., F.A.C.S., Hartford, Connecticut

THE writer has undertaken to make a few observations on cancer of the rectum based on the records of 53 cases, for the most part treated at the Hartford Hospital in the last 20 years. His interest has been stimulated by the fact that he has personally been able to follow a few of them over a relatively long period of time. Twelve of them have come under his personal care. Being under the observation of many doctors, the records obtainable are variable. For the most part, they are very incomplete and leave much to be desired. They have been taken, however, in seriatim. None has intentionally been omitted.

SEX

Of the 53 cases, the sexes are almost equally divided; 26 were males and 27 females. In the Hartwell series, 26 were males and 20 females. In studying the subject of cancer of the rectum, one must constantly think of a possible relation between syphilis of the rectum and subsequent cancer. It has occurred to me to compare data in these 53 cases with similar data in cancer of the tongue, wondering whether it may be possible to demonstrate any similarity in cancers of the two ends of the alimentary canal. One might be led to suppose that there would be some similarity because there is much in common in the embryology of the two regions. But in this very first matter of sex, we find a marked difference. In 22 cases of cancer of the tongue, occurring at the Hartford Hospital and recently studied by my brother, Donald Wells, 20 cases were males and 2 were females. There must have been just as much syphilis in the rectum as in the mouth and as much in females as in males. These figures seem to argue, therefore, that syphilis is not a cause of cancer and the discrepancy in the relative number of the sexes suggests very strongly that the other factor, namely smoking, is the reason for the preponderance of males in cancer of the tongue. It is interesting in connection with this to remind you that cancer of the tongue does not appear in the literature until about the time of the discovery of tobacco, a date which also coincides closely with the appearance of syphilis in Europe.

AGE

The ages at which these patients entered our observation were as follows:

TABLE OF AGES

	Cases
20 to 30	1
30 to 40	4
40 to 50	9
50 to 60	7
60 to 70	15
70 to 80	13
80 to 90	2
Not stated	2
	53

It is thus decidedly a disease of advanced age. Yet there appears one case at the age of 22. John Hartwell also reports one case at the age of 23 and Watson reports cases at 17, 20, 21, and 23 years of age.

That a patient should suffer from cancer of the rectum at 22 seems, however, rather remarkable and perhaps suspicious. Yet the records of this case of ours are rather more complete than most of the series and prove to my mind beyond reasonable doubt that it really was a case of cancer of the rectum.

This girl was married, age 22, and first came under our observation August 1, 1908. She had been in the hospital a few weeks previously, and the diagnosis on this admission was ulcer of the rectum. It is recorded that she refused operation and left against advice. The patient was re-admitted within a week or two. On this occasion the sphincter was stretched and a mass was felt just inside the sphincter, bulging into the vagina. A section was removed for microscopic examination and the specimen was reported adenocarcinoma. Patient again left the hospital against advice.

It appears that she next went to another hospital where the growth in the rectum was removed. The result, however, was unfortunate as she became bedridden, was unable to lie on her back, and was re-admitted to the Hartford Hospital 1 year and 3 months later in a pitiable condition and soon died.

Our second youngest patient might also come under suspicion of syphilis rather than cancer, the more so, that he is still alive and well now, 14 years since his operation.

His first symptoms appeared at the age of 31 when he noticed blood in the stools, followed later by griping pains. One year after these first symptoms, he came to me and was referred by me to P. R. Bolton, my former attending surgeon at the New York Hospital. Dr. Bolton removed a carcinoma involving an area the size of a silver dollar. A modified Kraske operation was done. The tumor was found just within the anus involving the anterior and lateral walls and was removed, leaving the sphincter to a considerable extent intact. "The specimen consisted of a portion of rectal wall 9 by 3 centimeters. Except for a narrow rim of normal gut, the wall was the seat of an oval ulcerated tumor the edges of which were fairly sharply defined. The tumor tissue was confined for the most part to the mucosa but in several places had penetrated to the muscularis. A microscopic examination showed an adenocarcinoma of a not very malignant type." The patient began to increase in weight immediately but did not regain full control of the sphincter for more than 6 months. There has never been any sign of return of this cancer and yet it was removed by very conservative methods. I have seen this man on the street and talked with him within a few weeks. There has never been any serious secondary stricture. I believe the explanation of this is that the growth did not involve the posterior wall of the rectum and the whole circumference of the rectum was not removed.

Wherever the rectum is resected and a circular suture done, a stricture always occurs as a result, and this stricture sometimes causes almost as much trouble as the original cancer. An end-to-end anastomosis of the intestine can be made at any point where the intestine is entirely surrounded by peritoneum, but as soon as we get beyond the rectosigmoidal junction and into the rectum proper where there is peritoneum on the anterior surface only, or still farther where there is no peritoneum at all, resection with circular suture cannot be done without producing a stricture. Such a stricture requires constant dilatation to maintain patency. This case speaks wonders for the possibility of conservative surgery in localized rectal cancer.

USE OF CYSTOSCOPE IN EXAMINING RECTUM

The question arises as to how one is to tell whether such a cancer is localized or not. The use of the cystoscope for this purpose was suggested by my associate, T. N. Hepburn, and I have not run across, in the literature, any other reference to this method of studying these cancers. Acting on Dr. Hepburn's suggestion, we have used this method a few times in our service at the Hartford Hospital with great satisfaction. The patient is placed in the knee-chest position with the abdomen relaxed. The cystoscope is easily introduced, the rectum washed clear, and filled with water as in bladder examinations. If pains be taken with the washing, it is astonishing what a perfect picture of the growth can be had. And it should be possible to tell with certainty whether or no the malignant ulcer in question involves the whole circumference of the rectum or not.

CONSERVATIVE SURGERY IN CANCER OF THE RECTUM

In the 1917 *Collected Papers of the Mayo Clinic*, Mayo describes the removal of localized papillomatous tumors of the large bowel or rectum by linear incision through the wall of the bowel by the abdominal route and removal of these tumors by conservative methods. The tumors he describes are not actually cancers, but they must be at least potentially so as shown by our Case No. 21 in which A. M. Rowley, in 1914, removed through the anus by conservative methods, a papillomatous tumor in a patient aged 60.

This tumor was regarded at the time of operation as merely a papilloma but on study in the laboratory was found to have undergone carcinomatous degeneration. The patient left the hospital apparently well. A letter received from the daughter a few days ago says: "He never had one sick day from that time until the summer of 1919." From that time on he began to fail. He died November 16, 1919, with symptoms suggestive of cancer of the stomach. This patient had lived and been perfectly well for over 5 years after the removal of an adenocarcinomatous polyp by conservative surgery.

Arthur Dean Bevan in the *Chicago Surgical Clinics* for 1917 describes a method by which he removes the coccyx and then slits the rectum posteriorly from the anus up a distance of 4 inches. This gives him a splendid exposure through which he is able to remove localized carcinomata with the cautery. He then loosely closes this wound and then the

wound of approach. He says that during the last 5 or 6 years he has operated upon several cases by this method and he believes it is a method that should be adopted in beginning small carcinomata of the rectum without serious involvement; that, if he himself had such a condition, he would prefer this operation done thoroughly to any other. He says that he has a number of cases alive and well 2, 3, and 4 years after these cautery operations in the lower bowel.

The above is about all that can be said in favor of conservative surgery on cancers of the rectum. And it is evident that before conservative surgery can be undertaken in any given case, a fairly accurate knowledge of the location and area involved should be determined.

SLOW COURSE OF CANCER OF THE RECTUM

There is one other feature, however, to which attention should be called and that is the very slow course which some cancers of the rectum seem to pursue. Such a case is illustrated in Case 1 of my series.

This patient had had stomach trouble, constipation, and generally poor health for many years. She had had ribbon stools and difficulty in defæcation for 1 year. It is reasonably certain, therefore, that her cancer started at least 1 year prior to the date of her operation, or about January 1, 1903. She was operated upon by Dr. Bolton, at the New York Hospital, February 8, 1904, at which time he made a posterior approach, resected the rectum containing an adenocarcinoma, did an end-to-end suture, and established a temporary left inguinal colostomy. "This specimen was the lower 8 centimeters of the rectum. A moderately indurated ulcer involved all except 1½ centimeters at either end. The mucosa below the ulcer was normal, but that above was indurated, at one point right up to the line of excision. The lumen was reduced moderately more in the upper than in the middle and lower parts. Sections showed a typical adenocarcinoma with slight mucoid degeneration. The ulcerated area showed invasion of the muscular coat. At one point the mucosa was involved close to the upper incision."

This patient was referred to me on her return from New York, May 30, 1904, at which time, there was a marked stricture in the rectum about 3 inches from the anus. She has been closely under my observation ever since.

In December, 1906, the patient became pregnant and in the following spring I noticed, first, a softening and reduplication of the scar, and later a definite mass which could be none other than a recurrence of the tumor removed 2 years previously. After consultation, it was decided to let the pregnancy continue and in October, 1907, she was delivered normally of a boy who is living today. The tumor at this time was about the size of a hen's egg. Operation was advised and urged immediately thereafter, but she could not be induced to go through it until February, 1913, over 5 years after the birth of her child. In the meantime, the growth had infiltrated the floor of the vagina and the sacrum. In April, 1912, O. C. Smith saw the patient in consultation with me and considered the involvement so extensive as to be inoperable. But in February, 1913, 10 years after the original symptoms, 9 years after the original operation, and 6 years after the recurrence of the growth and the birth of her child she went to New York and was operated on by William Seaman Bainbridge. He removed the entire rectum and anus, the coccyx and all of the soft tissues in the pelvis back of the vagina, making an entirely new perineum. This woman again resumed her natural life, did her own work, took care of her family, and went out in society. The artificial anus never gave her any trouble, never soiling her clothes, nor interfering with any of her activities. She never had any further recurrence until 1919, when she passed the menopause. Pain began in the region of the sacrum and in August, 1919, she became more or less bedridden from pain. A suspicion of return was of course immediately entertained but it could not be demonstrated with certainty until December. Dr. Bainbridge came to Hartford and again tried to stay the growth. The patient died December 22, 1919, at least 17 years from the time the growth started.

This case in particular has certainly served to impress on me the very slow rate at which this disease may grow and metastasize. There was never any reason to think that this patient had any metastasis beyond the immediate growth, and this can be asserted very positively because at the laparotomy last December, we had an opportunity to study the lymphatics in the rectoperitoneum as well as in the liver.

I have seen a number of other cases, however, where the course of this disease seemed to be quite as rapid as is the case in malignant disease elsewhere. I have opened the abdomen several times in patients where symptoms did not go back very many weeks and found the retroperitoneal lymphatics thoroughly invaded.

SYMPTOMS

I have studied the early symptoms in the 53 cases of my series, with the following results:

Pain was the principal symptom in 28 cases; blood in the stools in 27 cases. These two symptoms were predominant in the Hartwell series also. Loss of weight was present in 19 cases, obstruction to defæcation in 18 cases, diarrhœa in 11 cases, foul discharge in 10 cases, an obvious tumor in the rectum in 8 cases, acute obstruction in 6 cases, incontinence of fæces in 6 cases, piles in 6 cases, urinary retention in 3 cases, urinary fistula in 1 case, prolapse of the rectum in 1 case, abdominal tumor in 1 case, and strange to say, ribbon stools in but 1 case.

I found evidences of syphilis or probable syphilis in the hospital records in 5 cases, but I believe this is of no particular value because the internes taking these histories were not looking especially for symptoms of this kind either in the individual or in the individual's family history.

In 6 cases, acute obstruction was the first symptom. In all of these cases, the obstruction had lasted from 5 to 8 days. All did well after colostomy, except the one in which the obstruction had lasted for 8 days.

COLOSTOMY

There may possibly be room for variable opinions as to whether a colostomy in hopeless cancer of the rectum affords sufficient relief to justify it, but there can be but one opinion as to the surgeon's course of action.

If we see a man drowning, we do not consider whether that man's life if restored will be a blessing to himself and those around him. Neither do we consider the chances as to whether the venture will be successful. We throw him a rope if we can, concentrate our minds on the doing and leave the philosophy for the firelight and the pipe dream. Such is the rule of surgery.

I think there can be no doubt, however, that the colostomy in itself, not only relieves obstruction but at the same time decreases very markedly the irritation of the cancerous ulcer and removes a very considerable source of chronic poisoning for the individual by draining the cesspool of dilated colon proximal to the partial obstruction. Robert Abbe laid great stress on these features. The neglected cases are frequently complicated by fistulous tracts and become indurated, septic masses of tissue. These must be benefited by emptying the colon and so putting at rest the parts involved. Many writers say that an apparently inoperable case occasionally becomes operable as the result of colostomy.

A great many cases in this series doubtless had their lives prolonged very materially by this operation alone. It was done 18 times as the only surgical measure undertaken. Only 2 cases died from operation.

A colostomy is not the dreadful thing we used to think it was. The patient I have previously noted, used a colostomy for 16 years and I know it was the least of her troubles. She merely wore a belt with a single gauze sponge beneath it. She had full warning when her bowels wanted to move and never soiled her clothes.

One patient on whom I did a colostomy in 1915 wore nothing whatsoever over it and lived 8 months thus. This was a permanent colostomy, the sigmoid having been cut in two and the proximal end brought up through the left rectus muscle. My note of June 2, 1916, says: "Colostomy gives absolutely no trouble. Does not even have to wear a pad over it. A retracted, red dimple with hole invisible."

I believe this is the best form of colostomy, bringing the opening almost as high as the navel, leaving a good loop of sigmoid, and bringing the gut straight through the middle of the left rectus muscle.

I must admit some doubt that any twist or attempt at valve formation can long remain except in the operator's fancy, but perhaps I am mistaken. I have usually drawn the gut straight through the abdominal wall in the simplest, most direct fashion. And, so far as I know, with the exception of my most recent case who reports that he is wearing a colostomy cup, none of my patients have ever wanted anything more than a gauze pad and belt.

SYPHILIS OF RECTUM COMBINED WITH CANCER

One case in which I did a permanent colostomy for what I supposed was an inoperable and hopeless cancer of the rectum, remains a conundrum and is well worth relating.

This patient, Case 15 of my series, had been operated upon for piles in Russia about 1897 and again in Brazil 10 years later. She had had condylomata of the buttocks and rectum for many months and had been treated by various doctors here in the city. On October 25, 1910, she was referred to me by Dr. Standish, who suspected cancer of the rectum. She went to the hospital and I examined her under ether with the intention of obtaining a specimen for examination. To my surprise, I found it impossible to get even a finger into the rectum. The anus was a tight ring like shoe leather and appeared to be the same further up. Two days later, I made a left rectus incision. My notes read as follows: "The space anterior to the uterus is obliterated by adhesions. The left broad ligament is thick and filled with a fairly hard mass. The rectum loses itself in a mass of adhesions posterior to the uterus. These masses are hard and nodular and undoubtedly represent an inoperable cancer. Simple colostomy done through middle of left rectus. About one-fourth rotation given to the proximal end." The patient was discharged a few weeks later in good condition.

Two years later, I saw this patient. She had gained 42 pounds in weight, and had one or two movements of the bowels a day with full control. But she had come to me again because she had begun to lose weight and suffer pain in the back and legs. She also complained that a certain amount of discharge had recently occurred from the rectum. In December, 1913, I saw this patient again with H. F. Stoll. I could not understand why the patient had not died and my mind was giving all the credit for the stay of the disease to the colostomy. But in view of the unexpected result, our minds naturally turned to the possibility that the whole disease might have been due to syphilis. The fact that she had had syphilis and had had syphilis of the rectum was not disputed. I turned her over to Dr. Stoll, therefore, in December, 1913, and he treated her for syphilis then and at intervals since. This patient has been in the Hartford Hospital for various reasons and at various times but each time the diagnosis has been cancer of the rectum.

In May, 1915, my physical examination shows her as "emaciated." The rectal examination at this time was still as before described. In another history at the hospital a few months later, she is described as having "œdema of the feet." My notes show that she not only occasionally visited the Hartford Hospital about this time but other hospitals, including Mt. Sinai. At any rate, she was frequently receiving antisyphilitic treatment from Dr. Stoll, more especially about 1915, and the latter part of that year she began to feel better. Her pain disappeared, she grew stronger, and began to gain in weight again.

For several years now, this woman has been in excellent health. And to bring the case up to date with a fitting climax, we now learn that she was again married about 4 months ago.

Two questions present themselves regarding this case. First, did this woman ever have a cancer? Second, did syphilis cause the cancer or did syphilis cure the cancer? The rectum is still obstructed by a stony, hard mass. It will scarcely admit a slate pencil.

One conclusion I think may be drawn from this case. If the rectal obstruction really represents the scar tissue of syphilis, the salvarsan may have cured the syphilis, but at least it had no effect on the scar tissue. Why cannot we apply this result to the problem of parasyphilitic conditions in the nervous system and conclude on the basis of this case that we may cure syphilitic infection of the brain and cord, but let us bear in mind, that we cannot remove the scar tissue, which, after all, is the real pathology of these conditions.

Because of the case just described, I was extremely interested in a specimen of rectum removed by Dr. Hepburn at the hospital very recently. This specimen was simply a thick leathery tube. The walls of it were one-third or one-half an inch in thickness. It did not suggest cancer at all but appeared as a circular tube composed mostly of fibrous tissue. Its caliber was very small. There was no ulcerating surface and nothing to suggest a tumor. Dr. Hepburn and I both felt sure that the specimen represented an old, diffuse syphilitic stricture but the report from the laboratory was scirrhous carcinoma.

The sections show "a deep invasion of the connective and muscular tissues by small cuboid epithelial cells following the lymphatics. They are massed in small acini or found in long rows. The nuclei are small and pyknotic but mitoses are few. Only occasionally do these cells form gland tubules." There was no suggestion of ulceration of the rectal surface anywhere. Does a specimen like this represent a cancer of the rectum in process of cure by gradual fibrosis and did the case previously mentioned represent a case in which fibrosis actually went through to a cure in the 10 years under which we have watched her? I do not think such a view entirely unreasonable. We know that well authenticated cases of cancer in other parts of the

body have undergone spontaneous fibrosis and cure.

OPERABILITY AND MORTALITY

In the series of cases under present consideration, there were fourteen attempts at radical surgery; three by the sacral route only, made operative recoveries. One case was operated upon by the abdominal route only and made a recovery. Five by the combined abdominal and sacral routes in two stages, also all made operative recoveries. In five the two routes were combined in a single stage operation, and all died as a result of the operation. This has been the experience of most operators, that the combined operation in one stage has a very high mortality.

By comparison with the great clinics of the world, our little series of 53 cases is small. For the most part, it represents palliative treatment only. In 18 cases, no operation of any sort was undertaken. Usually this meant that the patient had a sloughing mass in the pelvis without obstruction. In one or two instances, a colostomy which might have been done for relief, was refused by the patient. In 4 cases, an operation through the anus was done, usually for examination, relief of septic conditions, etc. In only 14 cases was radical surgery attempted, an operability of 27 per cent.

Cripps, of St. Bartholomew's Hospital in London, reports an operability of 25 per cent, even less than ours.

Lynch, of New York, reports operation attempted in 60 per cent of his series; more than twice as many attempts as in ours. His operative mortality was 16 per cent; ours was 36 per cent. However, of the last 6 attempts in the Hartford Hospital, only 1 has died, making it in late years 16.6 per cent.

The Mayo Clinic puts their operability at 53 per cent with a rise to 72 per cent in the last 3 years. Their mortality has been 15.5 per cent reduced in the last 3 years to 12.5 per cent.

It is manifest in all these series of cases that the operability has been increasing rapidly in very recent years and the operative mortality markedly decreasing.

Wherein have we failed then? Of course, in early diagnosis. That goes without saying. Some cases cannot be diagnosed early. Others, it seems, might be.

We have not employed surgery that was daring enough.

We have thought of cancer of the rectum as a hopeless condition. It is not. Cripps reports one proved case that lived 31 years after radical operation and died at the age of 84. It can be cured. Let us have the courage to make the attempt.

RENAL HÆMATURIA AS A SYMPTOM OF A PRENEPHRITIC CONDITION OF THE KIDNEYS

By EDWARD L. YOUNG, Jr., M.D., Boston

SINCE 1910, approximately thirteen hundred cases have been treated in the house service of the Genito-Urinary Department at the Massachusetts General Hospital. Of this number about 40 per cent had hæmaturia at some time in the history of the disease, and by this I mean gross bleeding sufficient to attract the attention of the patient. This was not a prominent symptom in every case when seen by the attending surgeon, but active at some time in the disease. In many cases it was the presenting symptom, but in all but 21, the underlying cause was positively diagnosed on study. In addition to this number I am including 5 cases from the general surgical service which occurred during the same time and were carefully studied, and 7 cases in private practice where the data were sufficiently complete to make them of value. In actual number, or even when compared with the total number seen, this collection of cases does not seem very large; but when we consider them from the point of view of the possibilities of trouble to the individual, or as the first symptom of a condition which in certain cases may be remedied if taken in time, they seem of greater importance.

First let us consider some of the statistics shown in this list of 33 cases. The division by sex is decidedly unequal, only 8 of the cases being females. The division into decades is as follows:

	Cases
Below 20	4
20 to 30	8
30 to 40	7
40 to 50	10
50 to 60	2
Over 60	2

This symptom plays no favorites as regards age.

The duration varied from a few hours to 9 years, the case with the short history coming in with severe renal colic apparently due to the passage of blood-clot. The case lasting 9 years was intermittent and not accompanied by pain. Two cases had suffered for 6 years, one intermittently and one constantly, neither being accompanied by colic. The remaining cases varied from a few days in 4 cases to from 4 to 12 months in 4 cases. These were about equally divided between cases in which the bleeding was constant and cases where it was intermittent.

Pain accompanied the condition in 20 out of the 33 cases, and the variation in amount and character was very great. In the case mentioned above, the patient was brought in writhing in agony, due, as we believed, to the clotting of blood in the renal pelvis and the blocking of the ureter; this pain was the first symptom in two attacks in which he was brought to the emergency ward and was followed by bleeding, once, an hour after the onset of the pain and once, about fifteen minutes. The last attack was less severe than the first, and in both, relief followed the passage of considerable bright red, partly clotted blood. In a few of the other cases the pain resembled renal colic, but in most it was a more indefinite condition and although it was on the side from which blood was coming, it was variously referred to the back, the flank, or the abdomen. In many it was not absolutely connected with the bleeding, as there might be attacks of bleeding without pain, or *vice versa*. In one case an innocent appendix had been sacrificed without any effect on the pain, which up to that time had been the only symptom. Later bleeding directed attention toward the urinary tract.

Culture of the urine was not mentioned in every case, but only once was there any evidence of infection. The urinary examination was not remarkable in any case. Only once is there mention made of more leucocytes than was consistent with the amount of blood and that case was sterile to culture.

Twice the patients insisted that the hæmaturia was often terminal. In one of these there was no pain of any kind, and I had the fulgurating machine all set up, only to find a profuse right renal hæmaturia which stopped within 24 hours after a pyelogram and has not occurred since, a lapse of 10 months. In the other case there was never seen any profuse bleeding from either ureter, and in spite of a nephrectomy for supposed tuberculosis there have been two attacks of bleeding since, so that his blood may have come from a congested bladderneck, or from the ureteric orifice, as the mouth of the right ureter was noted as being red and œdematous.

TREATMENT

Nineteen cases out of this series were operated on. Three nephrectomies were done, one primarily because the bleeding was so profuse as to threaten the patient's life and nothing less than nephrectomy was safe. One was removed secondarily because of bleeding after a nephrotomy, and one because of a supposed tuberculous infection. In two of these cases the bleeding has never recurred, in one there have been two attacks of bleeding since. Nephrotomy has been done four times. Two of these cases were not helped, one being made so much worse that the kidney had to be removed, and one case was apparently cured but continued to have microscopic blood. Nephropexy was done once where there was a movable kidney, with relief of symptoms. Nine cases had a decapsulation done, once accompanied by a nephrotomy and once by a pyelotomy. Of these 9 cases 5 were cured so far as our records show, 2 were temporarily helped but recurred later, 1 of these being now recognized as a chronic nephritic, and 2 were not influenced by operation. In 1 of these 5 cases the bleeding was stopped but the pain continued, which was contrary to the usual story, as the pain was more often relieved than the bleeding. In none of the 5 do our records prove a cure, as one case had previously showed a natural remission of 3 years. The kidney was merely handled in three operations, and in 2 of these the bleeding stopped. The third case turned out to be a horseshoe kidney and the condition was not helped. In 5 cases the renal pelvis was washed out and in 3 cases there has been no trouble since. One of these cases was washed with 1:1000 silver nitrate and 2 with adrenalin, and on the other 2 adrenalin and hæmoplastin have failed to help. In 3 cases, bleeding stopped completely after the pyelogram. In 4 cases, there was no treatment of any kind, and in 2 of these the mere passage of the ureteral catheter was followed by cessation of bleeding, and in one the bleeding stopped before there was any chance to investigate. Both of these cases have a definite story of trauma which probably accounts for the condition. In these it is obvious that it would stop regardless of treatment. The other I believe was a mild coccus kidney following tonsillitis, which I will discuss more fully later. This array would seem to suggest that you can choose your treatment, depending on how vicious you happen to feel at the time, and regardless of whether you do much or little you may or may not relieve the bleeding. Whether you cure or not is still more problematical. Where a definite condition is remedied, as fixing a floating kidney or a nephrectomy is done for cavernous angioma, the patients are of course cured; otherwise the results of any method of treatment are doubtful.

The renal function was rarely low. The function of the two kidneys generally agreed within the limits of permissible error; but in one case which a year later proved to be a nephritis there was no demonstrable function from the bleeding side and a normal function from the other, and in another case it was 30 on the affected side as against 50 on the sound side. The pyelograms showed no startling facts. In 6 cases the shadow was not normal; in 1 case the cupping was obliterated, in 2 cases the pelvis was "irregular" but obviously not pathological; in 3 cases it was considerably deformed and materially aided in the decision to operate. In 1 of these 2 cases, the kidney was removed and examination showed that the calyces were somewhat elongated, but for no obvious cause. Yet even here there was not the elongation so characteristic of malignant disease of the kidney. In the other 2 there was also a de-

pression of kidney function on the damaged side and a hypernephroma was strongly suspected; one of these turned out to be a horseshoe kidney. From 4 of these cases, specimens were removed for laboratory examination—the whole kidney in 3 cases and a piece of the cortex in 1. One showed an angioma of a papilla; one kidney which bled so profusely as to threaten life showed on careful examination by Dr. Wright nothing but congestion. His suggestion was an infection by a hæmolytic streptococcus, but as no such organism was shown in the urine before, or in the kidney after, operation this does not seem likely. The piece of cortex removed at decapsulation showed nothing. One kidney removed as a tuberculous kidney showed on examination the following: "Cortex normal, markings distinct. Pelvis normal, no ulceration in calyces; a few pinhead-sized, yellow, opaque spots surrounded by a purplish zone. Small focal collections of small round cells with fibrosis and desquamation of the glomeruli. Diagnosis: Chronic infectious nephritis." As neither the urine before operation nor stained specimens of these areas afterward showed any organisms, the infection was certainly not present when the patient was being studied, and as he bled twice after leaving the hospital before quieting down, the process was either bilateral or else was not the cause of the bleeding in the first place. Moreover, as it was not tuberculous and contained no other organisms, it would certainly have taken care of itself provided there was no other primary focus in the body to supply fuel to the flames.

Of these 33 cases, operation showed a definite pathological cause to account for bleeding in 3 cases: two horseshoe kidneys and one movable kidney. Beside these there are 2 cases where trauma was the probable cause, and one where the patient is known to have passed a stone from the urinary tract, and it seemed likely that the present attack was also due to a small stone. There is 1 case of cavernous angioma proved by pathological examination. This leaves 26 cases in which we are entirely at a loss to assign a cause or else have to consider some form of nephritis.

Keyes gives the causes to which renal hæmaturia may be due, outside of the common diagnosis, as follows:

1. Hæmophilia, scurvy, purpura;
2. Drug-poisoning (turpentine, cantharides, etc.);
3. Parasites (e.g., distoma hæmatobium);
4. Acute or chronic febrile diseases (scarlet fever, malaria);
5. Surgical diseases (hydronephrosis, renal mobility);
6. The passage of crystals;
7. Angioneurosis;
8. Chronic nephritis;
9. Papillitis.

Most of these conditions should lend themselves readily to diagnosis. The last two, however, may be very difficult to recognize, and we must add to this list the bleeding coming from a kidney which, even in the hands of a competent pathologist, reveals nothing out of the way. Moreover, the bleeding from such a kidney may continue until the patient's life is in danger if the kidney be not removed. I want to add to the list of possible causes one which, so far as I know, has never before been discussed, namely prenephritic congestion of the kidneys.

Up to about 1900, it was believed that chronic nephritis could not be the cause of renal hæmaturia without giving signs of its presence; but during the next few years several nephrectomies were done for bleeding, and a study of the kidneys afterward showed the presence of chronic nephritis. Since that time so much work has been done along this line that the possibility of nephritis as a cause of such bleeding is now very definitely recognized.

I believe that no one will question the following statements: That unilateral hæmaturia can be due to a bilateral nephritis, and that a nephritis can cause colic as well as bleeding. It is also stated that nephritis can be unilateral. Within the last few years, however, the work done in regard to the various nephritides has progressed to such an extent that it is again doubted whether a nephritis can be present without giving some evidence of its presence by some one or more of the different laboratory tests.

As proof of the importance of chronic nephritis as a cause of bleeding the section on "hæmaturia" in Richard Cabot's *Differential Diagnosis* gives good evidence. The cases studied all occurred prior to 1911 at the Massachusetts General Hospital, and in this study chronic nephritis comes first with 139 cases, all other pathological conditions of the kidney or bladder together, 128, and unknown causes, 78; so that the nephritis is responsible for almost as many hæmaturias as all other causes put together. Today there is no reason to believe that the proportion would be different, as the unknown causes, then so large, would probably work themselves down to 7 or 8 instead of 78, and the rest group themselves in about the same proportion as the other cases.

So far as I have been able to find out, tumor of the kidney need not be considered in this study, as no case of kidney tumor has been discovered on the genito-urinary service when operating for supposed essential hæmaturia. Moreover, Barney in his study of the renal tumors at the Massachusetts General Hospital, found only 18 out of 74 in which there was hæmaturia without pain, only nine with hæmaturia and without a palpable tumor, and only three where hæmaturia was the sole subjective symptom; so that I believe it is fair to assume that at least the majority of such cases can be diagnosed before operation. When we consider the diagnosis of renal varix or papillitis, it is more difficult to make any accurate statement as regards frequency of occurrence; but I believe that it seldom is the primary, though it may be the main, cause of bleeding, and when it occurs may be due to some other underlying condition, which so changes the blood supply of the kidney that the congestion of papillary veins normally present results in varicosity and bleeding. In this series it was proved only once. In 1898, the first case of varicose veins of a renal papilla was actually demonstrated. Since that time several other cases have been reported, notably 6 by Fenwick and 1 by Cabot from the Massachusetts General Hospital; but in comparison with the total number of cases in which diagnosis has been difficult the number is few, and I do not think we can consider them as an important source of these unexplained hæmaturias. There has been a more or less accepted belief that failure to make a diagnosis in these cases means either malignant disease or varix, and accordingly operation was indicated on the basis that if it were malignant disease, the only time to cure it is early, and if no malignant disease were present, decapsulation would stop the bleeding. The report of the cases in this paper tends to show that this is not a good ground for operative interference, for, as shown earlier in this paper, operation is no more likely to stop bleeding than catheterization and injection of the kidney, and malignant disease is rarely if ever discovered by exploration.

It is undoubtedly true that certain cases where the kidney has been examined by a good pathologist have failed to show any lesion to account for the condition. Morris, in his work on the kidney and ureter, mentions 3 cases in which he operated, removing the kidney, but was unable to demonstrate any lesion pathologically. In addition is the case which I have just reported. If we recognize the fact that a nephritis can be local in character, it is possible to understand how, even in the hands of a good pathologist, areas of damage might be missed. This can, of course, be true if we are to include under "nephritis" cases of focal infection, the so-called "focal infectious nephritis," cases which show for instance (to repeat the case just mentioned) "pinheadsized, yellow opaque spots which microscopically show collections of small round cells with fibrosis." In such cases there may be bleeding due to these local areas even though they are very small and difficult to find.

In a recent paper, O'Neil differentiates between toxic and infectious nephritis. For the practical purposes of treatment this seems to me on the one hand to bring us into the realm of hair-splitting, and on the other, into the borderland of cases lying between the so-called "surgical kidney" and what we have always considered the "medical" nephritis. The definite etiology of the various nephritides is, of course, not settled, but so far as we know anything about it no cause (outside of the

purely arteriosclerotic type) is seriously considered other than the absorption of toxin from some focus in the body. The mere physical presence of one or more bacteria in the kidney does not cause nephritis. It is the poison they produce that does the damage, and that poison can do the damage with equal ease, provided it reaches the kidney, regardless of whether the organisms are located in the tonsil or in the kidney. Moreover, when a group of such bacteria does locate in the kidney and does increase, an abscess may then result, and we are dealing with a surgical condition primarily. If such a localized area of infection is so small that only bacteria and no pus show in the urine, we cannot tell the site of the infection, because it has been proved without possibility of doubt that the kidney does excrete bacteria. Accordingly the mere presence of staphylococci in the urine cannot permit us to say that there is an "infectious" nephritis. That infection may be situated in the tonsil and the kidney simply excrete the germ, and if in the urine there is pus as well as bacteria, then the condition has been carried out of the class of nephritis and comes distinctly into the class of surgical kidneys, and by surgical I do not necessarily mean operative, since we have all seen cases of low-grade hæmatogenous infections of the kidney which clear up without difficulty. The recognition of organisms from the kidney should always demand the consideration of a primary focus in addition to the study of the kidney; so that to differentiate between toxic and infectious nephritis would seem to be a purely academic discussion unnecessary from the practical point of view, since operation is never necessary in either class of case except to stop otherwise uncontrollable hæmorrhage.

E. G. Crabtree, who has done more work in kidney infections than any other investigator in this country, emphasizes two things as necessary for the better understanding of these conditions: first, that the kidney must be recognized as both a secretory and an excretory organ, and that all classes of bacteria may pass through without lodging and doing permanent damage; second, that when bacteria do lodge in the kidney the type of reaction depends on the virulence of the bacteria, the relatively harmless colon bacillus passing through the glomeruli and tubules and only sticking when it reaches the pelvis, while the very virulent streptococci start at once to damage the glomeruli, and the staphylococci (which are of intermediate virulence) form miliary abscesses in the cortex of the kidney, but after they have left the glomeruli.

I believe this is the real answer to Rovsing's statement that he has cultivated pus-producing organisms from the urine, and later has found lesions in the kidney microscopically which he could not differentiate from chronic nephritis. He was, in fact, dealing with a case of chronic nephritis and happened to catch some bacteria which had been excreted by the kidney, perhaps coming from the focus which was the primary cause of the damage, and if so, in operating on the kidney he was treating what was in reality a non-surgical condition.

I have gone into this detail as I think it is necessary to get as clear an understanding as possible of the relation of infection in order to treat these cases intelligently. I will illustrate this argument by a few cases.

The first, a girl of 12 years, was brought in by her mother because of hæmaturia and slight pain on the right side. This had been present in diminishing amount for 3 days. The child had had a tonsillitis, and the bleeding came on just as that was beginning to quiet down. A catheter specimen of urine showed blood. A cystoscopy showed bleeding from the right ureter and a catheter specimen from that side showed the presence of staphylococci, as did the bladder catheter specimen. The left side was not catheterized, as only the single catheterizing instrument could be used and the child was too senstive to spend much time. It was impossible to state whether or not there were more pus cells than should be with the amount of blood. The child had definite costovertebral tenderness on the right side. On the second visit a few days later the bleeding had entirely stopped, but a few staphylococci were still present. A week after this, neither physical signs nor any abnormality of urinary sediment were present. It seems reasonable to assume that this was a slight coccus infection of the right kidney following the tonsillitis, and as such definitely the cause of the hæmaturia. This type of case does not need surgical interference unless it be of the more severe grade described by various men as "hæmatogenous infection of the kidney," "coccus kidney," etc. It is of necessity either self-limited, or destructive to the extent demanding operation.

The second case is one of Crabtree's, and illustrates a late stage of the damage due to the strep-

tococcus. A young man was on his way to school when he had a severe hæmaturia. His previous health was good except for repeated attacks of tonsillitis. Examination showed streptococci from both kidneys, with blood and pus. One kidney had no function at all and the other a much diminished function. On removal, the tonsils showed a culture of streptococci. In this case the damage had been done, and the removal of the primary focus could not cure because a progressive glomerular nephritis had long been present.

The third case does not show us the organism but apparently gives the focus of trouble. Male, age, 44, brought to the emergency ward because of severe right renal colic. So far as he knows he has been perfectly healthy up to about 3 hours ago, when without warning he began to have pain in the right flank radiating down to the groin. This shortly became very severe, and he was sent to the hospital.

Urine passed about the time of onset was normal in appearance, so far as he can remember. The first urine passed after reaching the hospital, when the pain was beginning to subside slightly, was bloody. General examination at that time was negative except for slight costovertebral tenderness. Cystoscopy was negative except for bleeding from the right ureteric orifice. X-rays were negative. A two-hour red test was 55 per cent. The patient at that time did not wait for further examination, as he felt perfectly normal. Three weeks later he had another attack similar in character. At this time a more careful examination was made and the medical consultants went over him with reference to chronic nephritis. The first specimen of urine passed contained blood, specific gravity 1008; slight trace of albumin; no sugar. The sediment contained no organisms, nothing but blood. Bleeding stopped in 36 hours. The urine was then acid; specific gravity 1020; no albumin; no sugar; blood pressure 170-110; blood nitrogen 33 milligrams; blood sugar 0.4 per cent; creatinin 1.4 milligrams; specific gravity fixation test showed fixation between 1020 and 1026; second red test 65 per cent. Heart shows no abnormality. Medical diagnosis: a slight amount of arteriosclerosis, but no evidence of chronic nephritis. The patient had no more attacks of renal colic, but had a recurrence of previous trouble with the throat for which he had been treated in the out patient department under the diagnosis of chronic tonsillitis, and for which operation had been advised He was then seen by the medical department in the out patient department for his general condition, and sent into the house with a diagnosis of subacute nephritis. Study at that time showed a blood pressure of 180-115, with a specific gravity fixation of only 1020 to 1022, and a positive diagnosis of chronic glomerular nephritis was made.

Two more cases are given in detail, as they present either an early unrecognizable nephritis or a prenephritic condition causing bleeding.

Case 4. Male, age 50, had suffered with painless hæmaturia for 14 months. General condition excellent. Examination showed right renal hæmaturia with sterile urine. Blood pressure 150–80; split function, left 25 per cent; right, no function. Pyelogram not satisfactory. Total function 45 per cent. Medical study showed no evidence of nephritis. Operation showed nothing and decapsulation was done. Bleeding was much better for some time but in a few months returned, and one year later his out patient record shows that he is under treatment with positive evidence of chronic nephritis.

Case 5. A chauffeur, age 28, had to give up work because of pain in the left flank. This had been accompanied by red urine for several weeks. Examination by a medical man and by X-ray showed nothing to account for the bleeding. Cystoscopic examination showed a slightly bloody jet from the left ureteric orifice. Split function at that time and 2 months later showed a good output in the proportion of 10 on the right to 7 on the left. Pyelogram showed a perfectly normal outline. Following these examinations the bleeding perceptibly diminished for several weeks; but the patient felt no better and looked pasty. Further examination showed a blood nitrogen which was normal. Blood pressure normal, specific gravity fixation showing variation of eight points; but cystoscopy with catheterization of both kidneys, at a time when no red blood-cells showed under the microscope, showed a large amount of albumin from each kidney. The patient has been tested without result for the various strains of bacteria supposed to produce damage to the kidney.

The first three cases show plainly the primary focus. In the first case tonsillectomy will probably safeguard the future. As the organism was a staphylococcus, we cannot assert that continued assaults on the kidney would have caused a nephritis. It might have resulted in a severe coccus kidney, or there might have been no further renal complication from it. In the second case it is safe to claim that in the early or prenephritic stage removal of the tonsils would probably have prevented the later damage. In the third case, likewise, although no organism was identified it would seem as though early tonsillectomy might have prevented the late kidney damage. In the fourth case no focus was recognized, and in the fifth which I think is still in the prenephritic stage, no primary focus can be found.

That some of these cases have gone for a long time without evidence of a nephritis does not I believe destroy the argument for the

prenephritic congestion as a cause, since we certainly do not know how many assaults from a primary focus are necessary before a nephritis becomes self-continued, or what are the conditions under which the prenephritis becomes in fact a progressive destructive disease.

In one of the most important contributions to medical literature made in a long time, *The Future of Medicine*, Sir James Mackenzie elaborates the argument which runs in brief as follows: That the aim of medicine should be the prevention of disease; that the progress of medicine to the present time actually has been from the other end, the first accurate knowledge coming from the disease after it had killed its host, and the study being made in the autopsy room and the laboratory. From that came the development of the means of recognition of disease after it had done its damage, and the great need now is the development of the means of recognition of pre-existing conditions where disease has not yet done damage to the tissue, and when it is in its curable stage, if ever curable.

The precancerous stage has now been talked about for some time, and the treatment of those lesions known to be the occasional forerunners of cancer holds a recognized place in therapeutics. I believe that hæmaturia may be a sympton of sufficient importance to attract attention, due to a stage in kidney disease where the damage is very slight, and where a cure and restoration of the renal tissue to normal may confidently be expected if the primary site of trouble can be recognized and eliminated.

I realize that I have not proved my point as well as I wish, and even if I had, that the number of cases of hæmaturia from a prenephritic condition in comparison with all the cases of nephritis is so small as to result in very little actual progress in curing the disease; but what I hope is that the recognition of this possibility may be another step toward the goal of preventive medicine.

CONCLUSIONS

1. The cause of renal hæmaturia can be demonstrated in all but a very small proportion of cases.

2. Kidney bleeding of unknown origin has been known to be enough to threaten life and require nephrectomy.

3. A horseshoe kidney, a slightly movable kidney, a varix of a renal papilla may occasionally exist without the possibility of positive pre-operative diagnosis.

4. In a few instances the split function may show considerable damage on the bleeding side and the pyelogram a considerable deviation from the normal, a combination which should require exploration; but these cases are very rare and operation as a routine exploratory procedure in cases of hæmaturia of unknown origin is unwise, as there is no assurance that it will have any effect on the progress of the bleeding.

5. In a fair number of these cases a later nephritis has been proved to be the cause of trouble.

6. It is reasonable to believe that in a majority of these cases there is an early unrecognized nephritis or a prenephritic condition which can be, and probably often is, the cause of hæmaturia, and that this condition may or may not go on to a progressive damage of the kidney, depending on conditions which we do not as yet understand. In certain of these cases the primary focus of damage can be recognized, and when eliminated will prevent the later development of the disease.

DISSECTING INTERSTITIAL ABSCESS OF CÆCAL WALL

By FREDERIC HAGLER, M.D., St. Louis

INTERSTITIAL abscess of the cæcal wall is rare. We are led to this belief by the fact that we have not previously encountered it during an extensive experience of several years in connection with civil and military institutions. A. E. Halstead (1), of Chicago, has seen it once; inquiry has failed to bring to light any other similar cases. We find no references in the more recent literature, while voluminous records of the earlier literature are almost worthless on account of incorrect nomenclature and confused pathology. Knowledge of surgical diseases of the appendiceal region is now so definite that reports of unusual processes are desirable, especially those that may have contributed to the confusion of some years ago. The following case is sufficiently rare and interesting to warrant a report as much in detail as our retained notes permit.

D—. C—., Pvt. M. D., B. H. 87, was admitted to Camp Hospital No. 33, Brest, France, June 4, 1919. The history was of acute onset of abdominal pain about 18 hours prior to admission. Pain was at first colic-like and general over abdomen, but soon became localized to right lower quadrant. Patient was nauseated upon admission, had vomited two or three times, and had a chill earlier in the day. The bowels moved without catharsis soon after onset of illness.

Examination. Well developed and well nourished white soldier. Tongue heavily coated. Lungs and heart normal. Marked abdominal rigidity, more pronounced on right side. Very tender in McBurney s region. No mass palpable. Temperature 103.2°, pulse 96. Leucocyte count 22,000.

The typical history and objective findings led to the diagnosis of acute appendicitis, and immediate operation was performed.

Operation. Ether anæsthesia. Kammerer incision. Upon opening and exploring the peritoneal cavity the appendix was found to be but slightly injected. A firm mass, regular in outline, the size of a large fist, was found involving the entire cæcum. There were no adhesions, the cæcum was dusky in appearance but was mobile, and the entire cæcal mass was brought outside the peritoneal cavity. The general appearance of the mass suggested new-growth, while the clinical history spoke

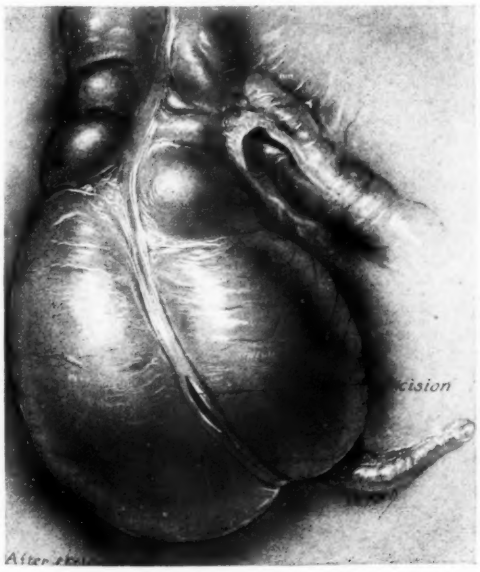

Fig. 1. Drawing showing line of incision.

Fig. 2. Abscess of cæcal wall.

for an acute inflammatory process. While examining the mass further, with reference to the advisability of resection, fluctuation was detected. A one-inch vertical incision was made through the anterior longitudinal muscle band, and much foul pus escaped, upon which the mass for the most part collapsed. It was then determined that the pus collection had been between the circular muscle layer and the submucosa; and although the abscess was so large as to have dissected practically the entire circumference of the cæcum, there was no evidence of either gangrene or perforation. A cigarette drain was inserted into the abscess cavity and stitched to the margin of the incision which had extended through the serous and muscle coats. The cæcum was then replaced after careful cleansing, and the abdominal incision closed.

The postoperative course was entirely regular. No evidence of fæcal fistula ever developed, the drain was removed in one week, and three weeks after operation the patient was evacuated as an ambulant case to the United States.

We are unable to explain satisfactorily the origin and development of this dissecting abscess between the layers of the cæcal wall. Jackson (2) and Moschcowitz (3) have reported diverticulitis of the cæcum, but in this case there was no evidence of a diverticulum or of any connection between the abscess cavity and the lumen of the cæcum. Infective organisms are always present in the cæcum, and according to Piersol (4) the submucous layer of the cæcum, like that of the appendix, is rich in lymphoid tissue, which is readily subject to infection. But these factors are present in all human beings, and if contributory causes, then infections and abscesses of the cæcal wall should be seen frequently rather than rarely.

Aside from the unusual character of the lesion in this case, it is remarkable that there should have been no adhesions or gangrene, and that the pus should have remained localized between the layers of the cæcal wall. Early operation probably accounted for this state of affairs. It is interesting to speculate whether perforation would have occurred into the lumen of the cæcum or into the free peritoneal cavity if operation had been delayed.

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BENIGN TUMORS OF THE LABIA[1]

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Assistant Professor Obstetrics and Gynecology, University of Minnesota Medical School

THE vulva may at any time become the seat of some form of neoplasm. They are quite rare, however, when compared with the frequent occurrence of tumerous growths in other areas of the urogenital tract of the female. It is exceptionally unusual to encounter tumors of the labia minora; only a very few are reported in the literature. The majority of these growths are confined to the labia majora. The cyst is without question the most frequent tumor met with in this region and usually arises from the Bartholin duct or gland, primarily caused by infection, trauma, or simple hypertrophy of the gland. They also may originate from hæmorrhages into the gland or duct, forming primarily a hæmatoma, which later undergoes a cystic degeneration. Dermoid cysts may occur in this locality but are exceedingly rare. Fibrous growths are second in frequency; lipomatous, malignant, myxomatous and leiomyomatous tumors occur in frequency of order named.

The series herein reported occurred in the writer's practice in the period of one year, which was considered unusual and unique and of sufficient interest to warrant reporting in detail.

CYSTS OF THE LABIA

Sebaceous cysts of the labia majora and minora are not uncommon. Occasionally thin-walled, pedunculated cysts are met with containing a clear fluid. They probably represent distended odoriferous (Tyson's) glands.

Cystic tumors of the labia majora are usually retention cysts of the Bartholin gland or duct due to obstruction, of inflammatory origin in the duct. The tumor may be confined to the duct provided the site of the obstruction is near the orifice of the duct. This is the most common variety, and usually the result of neisserian infection. If the obstruction occurs in the duct near its junction with the gland, the glandular structure may become involved, usually resulting in the total destruction of the glandular tissue. The condition may be bilateral. The patient usually complains of pain, especially aggravated at the menstrual period. The swelling may subside between the periods and gradually grow larger with the repeated distentions. If the patient is subject to sexual intercourse she will usually complain of dyspareunia. The tumors may rupture spontaneously, but usually recur if the cystic sac is not removed. The contents of the cyst may be watery, viscid, purulent, or hæmorrhagic fluid, or any combination of the above fluids.

PATHOLOGY

The wall of the cyst is usually thin, lined with one or more layers of squamous epithelium; some degenerated gland tissue may be found flattened out on one side of the cyst. If the gland itself is cystic the wall will consist of connective tissue and is lined with cylindrical cells. In the case here reported, the cyst was of many years' standing and had a hypertrophied layer of skin over the cyst, the wall was of thickened connective tissue, lined with squamous epithelium and the contents a chocolate colored, viscid, hæmorrhagic fluid.

Case 1. Female, white, age 32, widow, nullipara. The patient had never suffered from any severe illness; had had no temperature at any time. Ten years ago she was infected with gonorrhœa but did not follow medical advice or treatment. One year following the acute infection, she noted a swelling of the left labium, the size of a walnut. The tumor gave little inconvenience for several years, but the past 3 years has been growing rather rapidly. The patient consulted me because of the mechanical inconvenience of the growth, as it interfered with walking, urination, and cleanliness of the parts. The tumor appeared pedunculated, measured 13.5 by 8.2 centimeters, and was covered with skin with quite a marked growth of hair (Fig. 1). On removal of the cyst, large cavernous vessels

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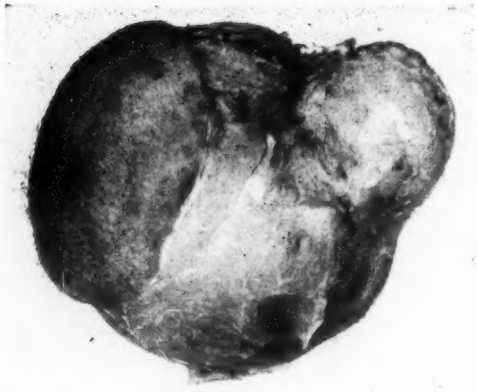

Fig. 1. Cyst of the labium, Case 1. The cyst was 13.5 by 8.5 centimeters in diameter.

were encountered and in depth the cyst extended to the deep fascia of the pubic arch, tapering inward to almost a point, having the appearance of a pear with a slight neck or constriction, 5 centimeters from the tip.

Operation. Local anæsthesia was employed in the dissection. Infiltration of the superficial tissues was made using ¼ of 1 per cent cocaine hydrochlorate solution. Two elliptical lines of infiltration beginning at the upper pole of the tumor and extending to the lower pole were made, as it was necessary to remove a large area of the skin covering the tumor. Blunt dissection easily relieved the tumor mass from the surrounding tissue. Some difficulty was experienced in controlling hæmorrhage as the base of the tumor was approached, as there were many tortuous large vessels close to the periosteum of the pelvic bone. Healing was rapid and uncomplicated and a fairly good labium was left.

FIBROMA OF THE LABIA

Fibrous growths of the labia while rather uncommon are next to the cyst in frequency of occurrence, and are the most frequent of the benign, solid neoplasms met with in this area of the female genitalia. These tumors may undergo a cystic degeneration if neglected, for as the process of growth advances, circulatory impairment results, the tumor becomes œdematous, semifluctuant to palpation, and undergoes a cystic degeneration as they do in the uterus. This tumor, like the retention cyst of Bartholin's gland, is subject to the influences of the menstrual period; they increase in size, cause pain, and may become hæmorrhagic. In the event of pregnancy, the tumor usually shows the same changes, but in addition may take on a very rapid growth. V. N. Leonard[1] reports 12 cases with an excellent digest of the literature and an exhaustive bibliography. The writer advises anyone interested in the subject of fibrous tumors of the vulva to study this report. Because of an accident to the fibrous tumor of this group after removal, it was impossible to secure photographs or pathological material for study; hence it will receive but passing mention with the case history.

This tumor was causing no physical or pathological symptoms and on removal proved macroscopically a simple fibroma. The exact tissue fostering this growth was not determined, but doubtless was from fibrous hyperplasia about the Bartholin gland.

Leonard says: "Tumors of this region may attain greater dimensions than superficial fibromata in any other parts of the body." As a rule they grow rapidly and become pedunculated early. Many of them show some form of degenerative change. The subperitoneal fibromata, which originate in the pelvic connective tissue and grow along lines of least resistance, first appear at the vulva and are the largest tumors on record. The largest described weighed 268 pounds. (Buckner, Whitney, and Harrington). Two-thirds of the fibroids of the vulva originate in the subcutaneous connective tissue, one-third in the extraperitoneal portion of the round ligament.

Case 2. Female, white, age 30, married, nullipara. The patient was operated upon 7 years ago by the writer for bilateral salpingitis and oöphoritis, the pathological condition requiring the removal of all the adnexa except a part of one ovary. The above condition had been the result of an infection of long standing, accompanied by a chronic endometritis and metritis, associated with a chronic profuse vaginal discharge which caused more or less irritation about the vulva. Four years after the laparotomy, the patient noticed a small swelling of the left labia. The tumor caused little inconvenience; hence was neglected.

The patient was experiencing her regular menstrual periods, which, however, became gradually diminished in quantity. As amenorrhœa developed, this tumor began to grow quite rapidly and fearing

[1] Johns Hopkins Hosp. Bull., 1917, December.

malignant degeneration, the patient consulted me for removal of the growth, which at this time had attained the size of a large hen's egg.

Operation. The tumor was resected, local anæsthesia being used. No complications attended the operation or recovery.

LIPOMA OF LABIA

This is one of the rarest of gynecological affections. In Kelly's monograph published in 1906 he was able to collect but 20 cases from scattered literature. To that date he had had but one in his own clinic which was the smallest tumor of the above series measuring 2 by 1.5 by 1 centimeter. The largest was reported by Headley (Melbourne), weighing 24 pounds. Only two labial lipomata have been found in the Mayo clinic in the last 127,000 cases passing through the clinic. J. B. Murphy reports one case in 1916. Goodell, of Philadelphia, reported a case in 1887 which grew from a long, broad pedicle, and extended to the patient's knees.

Sturmdorf reported a case in 1909, in which the tumor had attained the unusual size of 12.5 by 10.5 centimeters in circumference. This patient was in the first stage of labor and the tumor was arresting the progress of the fœtal head. The growth was on the left labium majus and delivery was further complicated by an ankylosis of the hip-joint on the right. The tumor was excised and labor successfully terminated. Lipomata of the labia majora present the same characteristics as lipomata elsewhere in the body. They may project from a broad base involving the whole labia, as in Case 3, or the growth may be suspended by a more or less attenuated pedicle, as occurred in Case 4. These tumors may be readily mistaken for cysts, elephantiasis, hernia, varicocele, and fibroma. The tumor may vary in size, from that of a walnut to the 24 pound tumor reported by Headley, depending upon length of time and rapidity of growth. The microscopic pathology is the same as in any lipoma.

Case 3. Mrs. F. S., age 26, American (one-fourth American Indian), weight 182 pounds. The patient was admitted to the hospital for operation on December 26. The history was negative for fever or other illness. Menstruation began at the age of 11 years and has always been regular and

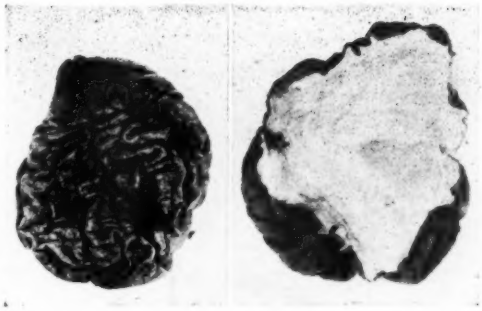

Fig. 2. At left, external view of pedunculated lipoma of the labium majorum; at right, cut surface of tumor.

normal. The first pregnancy, at age of 18, terminated at full term. Labor lasted 52 hours and a female child weighing eight and one-half pounds was delivered by forceps. The child died in 1 month, supposedly due to brain injury at delivery. The patient has had two criminal abortions since delivery of her first child. The patient consulted me for a tumor of the left labium, the size and shape of a large banana. She first noticed the tumor 4 years ago but it had grown rapidly the past 2 years. It was not pedunculated nor markedly lobulated. There was also a marked relaxation of the pelvic floor, a result of a laceration at the time of the forceps delivery 8 years previously.

Operation. The lipoma was resected and the pelvic floor repaired. General anæsthesia was employed. Convalescence was uninterrupted.

Case 4. Mrs. W. O., age 38, American Indian, married and had two grown daughters. Absence of any interpreter made it impossible to secure detailed history. The patient, suffering from incontinence of urine, was sent in to the hospital from the Indian Reservation on February 28, 1918. The external genitalia were normal, except for the pedunculated lipoma springing from the left labium majus. The genital parts and upper thighs were bathed in urinary secretion, rather foul, which had caused a marked dermititis. Vaginal examination revealed advanced inoperable carcinoma of the pelvic viscera, which had caused two large vesico-vaginal fistulæ. The patient died in 2 months in the State Hospital; no postmortem report was received.

Operation. The lipoma was ligated with a silk ligature and removed; the pedicle was very small and the tumor symmetrical but lobulated as shown in the photographs Figure 2.

MYXOMA OF LABIA

The tumors in this group are composed of a loose connective tissue with branched cells which are widely separated by a

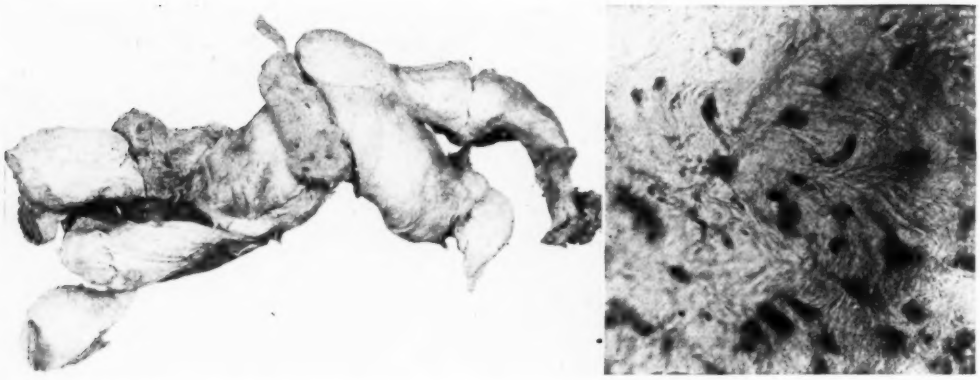

Fig. 3. At left, photograph of myxoma removed from Case 5; at right, photomicrograph of same specimen.

viscid, opalescent, mucoid substance which actually contains mucin. On the whole, the myxomata are rare, as the type tissue of these tumors exists only in the Wharton's jelly of the umbilical cord, which stands as the prototype of the myxomata. These tumors are found in various situations in the body; e.g., in subcutaneous and intermuscular tissues, in connection with tendons, periosteum, joints, and especially the heart. In most instances myxomata are benign, but occasionally they may show signs of malignancy and invade widely. They may even metastasize to other organs. One form of myxomatous tumors, which may attain the size of a cocoanut, is found in great nodular masses in the retroperitoneal region at the root of the mesentery. The masses are encapsulated and tend to recur after removal. Virchow distinguished different subdivisions of myxoma.

1. Myxoma gelatinosum—largely made up of homogenous intercellular substance.

2. Myxoma fibrosum—characterized by great development of intercellular substance.

3. Myxoma medullary—where we have an increase of its cellular elements and forming the transition to the corresponding cellular form of tumor known as myxosarcoma.

4. Myxoma cavernosum—containing many cavernous blood-vessels.

5. Myxoma telangectaticum — rich in capillaries.

CASE 5. Mrs. H. I., nullipara, age 34, Swedish, weight 180 pounds, admitted to the University Hospital February 10, 1918. The patient had been operated upon 7 years previously for appendicitis. Appendectomy gave permanent relief from pain which the patient had suffered for 1 year. Menstruation began at the age of 14, and was regular and normal, up to the past 4 years when the flow became rather scanty and caused pain. The patient complained of abdominal pain, dysmenorrhœa, and a tumor of the right labium majus which had been diagnosed as an inguinal hernia.

Operation by J. L. Rothrock, of St. Paul, to whom the author is indebted for the specimen, the case occurring in our department clinic, University of Minnesota. A mid-line incision was made through the scar of a ventral hernia repair, which was done 7 years previously at the time of the appendectomy. There were no adhesions of the abdominal viscera; the uterus was retroverted in third degree; there were firm adhesions of the left tube and ovary; chronic salpingitis and oöphoritis. Left salpingectomy and oöphorectomy were done. A suspension operation was not indicated. Thorough examination of the lower abdominal cavity was made to make sure the labial tumor did not originate from some abdominal viscera (for even an obturator hernia was considered), but no such opening or hernia was present. An incision was then made in the labium and dissection of the tumor begun. The mass extended from a point at the level of the vaginal orifice in the direction of and to the ischial tuberosity. The tumor on dissection reminded one in appearance and texture of a testicle and hypertrophied cord and epididymis. The tumor was 26 centimeters long, was not pedunculated, loosely surrounded by soft fatty tissue, scant in blood vessels, and had two diverticulum-like processes. Distinct cystic spaces were found in the diverticula, but contained no fluid. The tumor proved to be a myxoma. The true origin of the tumor is only speculative.

Pathology. Microscopic specimens show the classical histology of myxomatous tissue as found

in the umbilical cord, namely loose connective-tissue cells widely separated by a viscid, opalescent, mucoid substance.

LEIOMYOMATA

These tumors, also known as myoma levicellular, are of most simple pathology, growing from smooth muscle fibers and most common in the uterus, ovary, and gastro-intestinal tract. Less commonly they occur in the bladder, blood-vessels, skin, and nipples.

Leiomyomata are usually rounded growths, varying in size from minute nodules to solid masses weighing 60 to 70 pounds. They are surrounded by a capsule, which is well defined and more or less hard. In whatever location, they spring from pre-existing unstriped muscle fibers. Microscopically, we find bundles of muscle cells running in different directions. Cut longitudinally they show cylindrical nuclei as the most conspicuous feature. Lying between the muscle cells are collagen and so-called myoglia fibrils. The latter appear as coarse lines along the sides of the cells. Usually some fibrous cells are found in these tumors. The tumor herein pictured evidently arose from some small unstriped muscle fibers of the duct of Bartholin, and is of interest only from its location.

Stevens reports a case of rhabdomyoma (striped muscle tumor) of the vulva. The diagnosis might be questioned, however, as Johnson, Bland Sutton, and others contend that a tumor composed entirely of transversely striated muscular tissue has not yet been described, and it is probable that certain elongated and transversely striated cells occasionally met with are not really muscle fibers. Striated muscle fibers are, however, sometimes present in mixed tumors of the kidney and the testicle, occurring in early life.

CASE 6. Mrs. W., age 36; weight 200 pounds; born in Roumania; married 8 years, and has had no pregnancy by present wedlock. She claims never to have been pregnant, but marked laceration of the cervix uteri and of the pelvic floor suggests an early pregnancy, doubtless out of wedlock. The history is negative for fevers or illness. The chief complaint is a profuse vaginal discharge. She was treated locally for several weeks for the leucorrhœa, which resisted all efforts to relieve it. The tumor of the right labium minus was noted and diagnosed

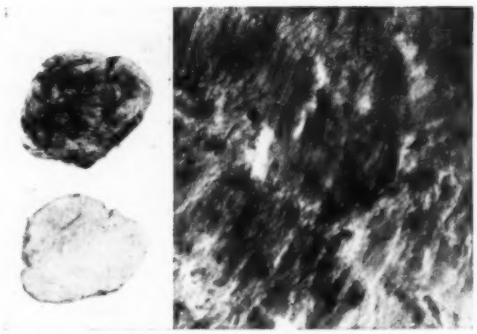

Fig. 4. At left, leiomyoma of labium, removed from Case 6; at right, photomicrograph of same specimen.

a cyst of the Bartholin gland and naturally considered of neisserian origin as also was the cervicitis and endometritis. The patient was curetted and the tumor of the labium removed (Fig. 4).

Pathology. Microscopic findings revealed a cystic hypertrophic endometritis and a leiomyoma of the labium. The tumor doubtless originated from the unstriped muscle fibers of the duct of Bartholin. Microscopically one notes bundles of muscle cells running in different directions. The cells cut longitudinally show cylindrical nuclei as the most conspicuous feature. Proper staining may show a substance known as collagen and myoglia fibrils, the latter appearing as coarse lines along the sides of the cell.

Proper and Simpson, of the pathological laboratory of the New York State Institute for the Study of Malignant Diseases, reports that malignant leiomyomata are not uncommon and may be defined as malignant neoplasms arising from mesoblastic cells of the smooth muscle type. It is conceivable that these tumors may originate from either adult, smooth muscle cells or from benign tumor cells as found in leiomyomata. The latter origin must be considered as the common one on account of the frequency with which a history of "degenerating fibroid" (1) accompanies these tumors.

Virchow, in his treatise on tumors, described in 1863 a myoma of the stomach which underwent a metaplasia to myosarcoma. While he speaks about its originating in the interstitial tissues, still his microscopic description of the cells and especially the nuclei leads one to believe that he had to deal with a true malignant leiomyoma to which he gave

the name myosarcoma. Ritter described a case of a large fibromyoma of the uterus which showed sarcomatous changes at the center and to which he gave the name myosarcoma. Von Kahlden reviews the literature and, after describing many reported cases, some of which were probably cases of true sarcoma as well as malignant leiomyomata, he describes a personal case which is of especial interest because he claims one can demonstrate histologically a direct transition of a fibromyoma to a sarcoma. Williams, after a careful study, does not see how Von Kahlden can exclude the possibility of the sarcoma cells springing from the interstitial connective tissue, although he himself described a case in the sections of which he could demonstrate an actual transition of myoma cells to sarcoma cells. Almost all authors of this period speak of these tumors as myosarcoma, but as Ribbert points out, the name sarcoma should be reserved for malignant tumors springing from connective tissue. For the smooth muscle tumor which has undergone malignant change he suggests the name of malignant myoma; and he would only use the term myosarcoma for the extremely rare cases when true sarcoma and myoma exist at the same time producing a mixed tumor. Ribbert also emphasizes the fact that the term malignant degeneration of a "fibroid" is improper usage inasmuch as a tumor is not a regressive but distinctly a progressive process. Much discussion has arisen regarding the best terminology to use, to designate these tumors arising from the smooth muscle type of cell. Mallory would include all tumors both benign and malignant which are composed of the smooth muscle cell type under the general term leiomyoblastoma. Williams prefers the term myomasarcomatodes because it signifies a sarcoma-like tumor which springs from the muscle cells of a myoma. Aschoff, Kauffmann, and Hertzler use the term myosarcoma, while MacCallum prefers the term malignant myoma. It would seem most rational to use the term suggested by Morpurgo, and also used by Ghon, viz., malignant leiomyoma, as this covers the ground and instantly shows one that we are dealing with a malignant tumor comprised of the muscle type of cell.

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CHOLECYSTGASTROSTOMY

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CHOLECYSTGASTROSTOMY or anastomosis between the gall-bladder and the stomach, has a limited application in surgery but on these rare occasions when it may be employed, it is an operation which may be depended upon to relieve a very serious situation for the patient and at the same time prove a simple solution for a complex problem for the operator.

It appears from a brief survey of the literature that in 1887, Oddi experimentally demonstrated in dogs that after ligation of the common bile-duct, an anastomosis between the gall-bladder and the stomach not only failed to interfere with digestion, but all the animals gained in weight. Masse confirmed this work in 1898. In 1892, Wickhoff and Anfelberger jointly recorded the first successful operation of this character in a patient who was suffering from a disease of the pancreas and gall-stones. Up to 1900 few cases were reported, but more recently Kehr, Moynihan, Mayo-Robson, and the Mayos have made mention of this operation in their writings.

A small number of cases coming to operation with the tentative diagnosis of obstruction of the common duct by stone, fail to disclose a concretion when explored, either because no calculus is present or the operator is unable to find a stone that is present. Stricture of the duct, pressure from a growth in the pancreas or the immediate vicinity of the duct, or an enlarged gland may be the underlying cause of the obstruction, and the external drainage of the gall-bladder not only fails to relieve the condition, but dooms the patient to a biliary fistula and inanition. It is by no means easy to open the duct and determine absolutely by a probe if the duct is patulous, although in most cases it should be attempted. Should we be dealing with a stenosis of the duct, aside from plastic surgery on the common bile-duct we have a choice of three operations to meet the indication: cholecystenterostomy, cholecystcolostomy, and cholecystgastrostomy. The second operation, linking up the gall-bladder with the colon, deprives the patient of his bile where it is most needed and results in feeble digestion. Cholecystduodenostomy ordinarily is the operation of choice, but with a fixed duodenum, the operation presents many difficulties. A perfect union is necessary and a failure results in a duodenal fistula, an abomination to the patient and his physician. In some cases the juxtaposition of the stomach to the gall-bladder renders the anastomosis between the organs not only possible, but easy, without the attending fear of a permanent fistula, for the thick walls of the stomach permit a secure union, and a leak is rarely followed by a persistent fistula.

The operation has been found useful in some forms of cirrhosis of the liver, a condition which can be conveniently and logically divided into two types—portal and biliary—and which may also be distinguished clinically and pathologically. In the former condition, cholecystgastrostomy offers no relief.

Biliary cirrhosis or biliary obstructive cirrhosis as designated by Adami, is stated by Ford to be due to one of the following conditions:

1. Congenital deformity or obliteration of the larger gall-ducts;
2. Gall-stones, or more frequently, by contraction of scar tissue which has developed about an ulceration caused by the passage of a sharp gall-stone;
3. Cancer of the head of the pancreas;
4. Enlarged glands at the hilum of the liver.

To this may be added, ascending infection, chiefly from the gall-bladder. This is perhaps the most frequent cause, either alone or in combination with the other enumerated causes. It is in obstructive biliary cirrhosis of the chronic type, that cholecystgastrostomy has its chief indication. While the disease is not common, it is by no means rare, and its infrequent recognition is in a large part due to the arbitrary classification and study of hepatic cirrhosis.

The disease bears no definite relation to the use of alcohol. It is characterized by digestive discomfort, gradually increasing jaundice, loss of weight, putty stools, afebrile course except during exacerbations when the patient may have pains and fever simulating gall-stone colic. The spleen as well as the liver is enlarged, but the liver may shrink to normal size.

The cause can usually be traced to an ascending infection from the gall-bladder. It has been shown by Rosenau that while the bile may show no growth on appropriate media, organisms can be found in the walls of the bladder and ducts which hold this sterile bile. The infection within the bile ducts eventually leads to thickening and blocking, with dilatation of the smaller bile-ducts, dilated blood-vessels and a cirrhosis of the liver in later stages which may be interlobular, intralobular, or pericellular.

An ascending infection is best met by draining the source of infection, the gall-bladder, and this is often sufficient to arrest the inflammatory activity in the ducts, but the drainage should extend over a long period. The usual cholecystostomy accomplishes much, but the fistula with its uncertain period of drainage, the tendency to heal and discharge at irregular intervals, the frequent dressings and irritated skin, are the uninviting features of this operation.

An anastomosis between the duodenum and gall-bladder, upon first thought appears to be the operation of choice, but it is at times difficult, if not impossible, and is attended with no little risk. Cholecystgastrostomy in many cases would prove easier of accomplishment with less danger of fistula, and judging from clinical and experimental evidence, quite as satisfactory. Unphysiological as it may seem, the results in cases reported warrant the statement that the bile in the stomach is not particularly detrimental, and the results have been most gratifying. It is not uncommon to find bile in the stomach of normal individuals.

The technique of the operation is similar to a miniature gastro-enterostomy. The gall-bladder and anterior pyloric end of the stomach are approximated for a distance of about 1¼ inches by a Lembert suture of fine chromic catgut, leaving a long end with the needle attached. Parallel to this line of suture an incision about ¾ of an inch is made in the stomach and in the gall-bladder, the edges of which are approximated by a glover's or locking stitch of No. 00 chromic catgut, converting the two openings into a fistula between the stomach and gall-bladder. The first line of suture is now continued above the fistula, making in all four tiers of sutures. Available omentum may be used to reinforce the anastomosis. The hæmorrhage is not troublesome. The wall of the stomach, and usually a thick-walled gall-bladder, permit deep bites with the needle, resulting in a firm approximation. A rubber dam drain may be used from the cholecystgastrostomy to the surface of the abdomen.

The Murphy button may be substituted for the suture method of anastomosis, but it is open to serious objection and the only possible excuse for using it would be in such cases where it is mechanically impossible to use the suture. The button may be dislodged, may get into and remain in the gall-bladder, or escape to the stomach. Ulceration and perforation following the retention of the Murphy button in the gastro-intestinal tract has resulted in a number of deaths.

We wish to report three cases:

Mr. V. J., referred to me by Charles Collins, gave a negative family history. He was considered a frail child and had scrofula up to the age of 6 years. At the age of eighteen he had typhoid fever and made a good recovery. He discontinued school at this time and farmed until the age of 26, when he entered government service as a clerk. He has always been temperate, using alcohol sparingly and has led a sedentery and uneventful life. His travels have never extended to the tropics. He dates his present illness from 1905, when he had slight jaundice with no pain. In 1910, he had a recurrence of jaundice with some discomfort. In 1915 he had 3 weeks of painless jaundice. On January 1, 1919, he had what he termed biliousness, characterized chiefly by nausea, vertigo, and jaundice 2 days later. There was pain of a dull character. The jaundice steadily deepened until by July he was almost bronze. The stools became light and of a putty consistency, and he lost about 60 pounds in weight. The temperature was normal and the pulse slow. The urine contained bile. Operation July, 1919. A right rectus incision disclosed a liver of normal size but of dark color. The gall-bladder was thickened but not enlarged and

contained many small stones. The other organs appeared normal. An anastomosis with the stomach was done by means of a small Murphy button rather than a suture, owing to the difficulty in approximating the gall-bladder and stomach, and the necessity for haste.

The first bowel movement following the operation was dark brown. The wound healed well and he was able to leave the hospital in 20 days. At the time he was discharged his stools were deeply colored with bile and his skin had lost the bronze hue but was still distinctly icteroid.

Dr. Groover reports the result of X-ray study, February 17, 1920:

"The Murphy button is in relation with the pyloric end of the stomach. It is probably where it was originally placed. There is very definite tenderness directly over the button."

A gastric analysis made by Dr. Clark, February 18, 1920, was as follows:

"A moderate amount of fresh golden bile, free hydrochloric acid 26, total acidity 36," with the additional comment that the gastric juice was not abnormal and was capable of good digestion. The patient weighs 40 pounds more than his last weight prior to operation and states that his health is good. The jaundice has completely disappeared.

We believe this to be a case of chronic obstructive jaundice, due to an ascending infection from the gall-bladder. The cause of the gall-bladder infection is not clear, but prior to his illness his teeth were the source of an infection that required the services of a dentist for some months. It is very possible that this was the exciting cause.

CASE 2. H. B., male, age 40, bank clerk by occupation. His parents are living and are in good health. He has had the usual diseases of childhood, but no protracted illness. He uses stimulants occasionally.

He dates his present illness from August, 1918, and first complained of pains in the epigastrium. These pains were at times severe but infrequent. He began losing weight in the autumn of 1918 and about January 1, 1919, the epigastric pains returned with shorter periods of relief between the attacks. During the early part of this month, he consulted his physician to whom he gave a history of luetic infection of about 10 years' standing. The blood and spinal fluid Wassermann reaction tests were positive. From January 13 to February 25, he received eight doses of salvarsan intravenously. During this period the attacks of pain radiating to the back were getting closer together, and morphine was necessary for relief. The pain was sudden and violent. About March 1, icterus became a symptom and it gradually deepened until he became lemon hued. The stools contained no bile. The urine contained bile but no sugar or albumin.

We saw this patient in consultation with Henry Schreiber March 27, 1919, and he was operated upon the following day. The only gross pathological findings was an induration in the head of the pancreas. The gall-bladder was not visibly diseased and the liver was not enlarged. An anastomosis by suture between the stomach and gall-bladder was made. The patient stood the operation well and stated he felt better the following day. The movements after the operation contained bile and in a few days the jaundice began to fade. His convalescence was rapid and satisfactory in every particular.

A fractional gastric analysis made by Verbrycke, February 18, 1920, showed that the contents when first removed were greenish yellow, contained some mucus, a trace of bile, a trace of blood, free hydrochloric acid 22, total acidity 33. The greatest hydrochloric acid curve was 75, 1¼ hours after the test meal was withdrawn and at that time the total acidity was 94. This remark is added: "The bile at this time is evidently going through the common bile duct and not through the new opening." At this date, the Wassermann is negative, and the patient has gained 35 pounds in weight.

The cause of obstruction in this case we believe was due to a gumma in the head of the pancreas.

CASE 3. A. McL., female, single, age 26, a clerk by occupation. The family history is of no importance. She had diphtheria during childhood. At the age of 14 she was ill 2 months following an injury to her left side, and shortly thereafter developed a tumor under the left costal border which persisted and enlarged slowly and is still present, a hydronephrosis we believe. At the age of 17 she had jaundice 3 weeks, with some pain in the upper right quadrant of the abdomen. In July, 1919, she complained of indigestion and on August 25, 1919, jaundice appeared. The pain under the right costal border became severe, paroxysmal in nature radiated to the right shoulder and penetrated to the back, and was attended with fever. The stools were colorless.

She was seen in consultation with Dr. Bradley August 27, 1919, and was operated upon the following day. There were a few adhesions about the gall-bladder, and it contained a number of small stones and pus. A cholecystostomy was done. She improved at once, and at the end of 8 days the drainage tube was removed, but the bile continued to flow freely for about 2 weeks, when the sinus healed. A little bile appeared in the stools at intervals. Shortly after the sinus closed, she was seized with severe pains simulating gall-stone colic, which was relieved by sudden discharge of bile from the wound. The jaundice cleared up somewhat while the bile was draining, but deepened when the sinus closed. There was a repetition of the damming and rupture of the sinus 2 weeks later. A second operation was done

about 6 weeks after the first. A careful search of the common duct was made for a stone or evidence of obstruction, but none was found. The liver was not enlarged. The common duct was not opened but should have been. In the absence of a satisfactory explanation of the obstruction, it was assumed that this was a case of obstructive biliary cirrhosis of an ascending infection, and with that in mind an anastomosis was made between the gall-bladder and stomach. In about 2 weeks the patient had a recurrence of the pain and increasing jaundice, but this was the last attack. Shortly after this the stools became normal, the icterus slowly disappeared and the patient left the hospital November 23, very much improved.

She writes under date of February 5, 1920, that she has entirely recovered and weighs 5 pounds more than before the operation.

The diagnosis in this case rests between infective biliary cirrhosis and a stone in the bile-duct within the liver.

Summarizing briefly, we reiterate that the operation of cholecystgastrostomy has a definite place in surgery, and this may be said of it:

1. It is indicated in an irremediable obstruction of the common duct or division of the duct which cannot be successfully sutured.

2. For long continued drainage in infective biliary cirrhosis it is superior to cholecystostomy in that nutrition is maintained.

3. It is not a difficult operation, being easier and safer to perform than an anastomosis between the gall-bladder and the small or large intestine.

4. There is no danger of an ascending infection.

5. The presence of bile in the stomach, while unphysiological in a degree, is consistent with good digestion, and offers no argument against the operation.

6. The suture method of anastomosis is the only one to be employed.

FURTHER OBSERVATIONS ON THE FUNCTION OF THE CORPUS LUTEUM[1]

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ACCORDING to our present conception, the ovary is a complex glandular organ with at least two quite distinct functions: first, the production of ripe ova and, second, the elaboration of one or more internal secretions. While neither of these functions is absolutely necessary to the life of the individual, the former is positively and the latter probably absolutely necessary to the propagation of the species and the latter very essential to the well-being and comfort of the individual. Up to the time of the advent of abdominal surgery, few, if any, suspected that the ovaries had any function other than the production of ova, and if one is to judge by the reckless sacrifice of these organs, most men utterly disregarded their second function even for a considerable number of years after gynecological surgery became generally practiced. When the number of nervous wrecks due to this practice became too numerous for the comfort of the operators they began to take heed. The practice of removing both ovaries except when absolutely necessary was discontinued some 20 or 25 years ago, and since that time also numerous studies have been undertaken to determine the exact function of these organs. While much has been learned from these studies, much is still to be learned.

Several years ago some very interesting data, collected by a number of veterinarians, came to my attention. These data have in part been checked up by me on the human female and are here presented with the hope that they may shed some additional light on the rôle played by the ovaries. I here confine my observations very largely to the function of the corpus luteum and the influence it seems to have on pregnancy, sterility, abortion, and intra-abdominal hæmorrhage simulating extra-uterine pregnancy.

[1] Read before Southern Surgical Association, December 17, 1919.

Veterinarians have observed that if a false corpus luteum remains unabsorbed in either ovary of a cow, she does not come in heat, and so long as she does not come in heat, she of course does not conceive. On the other hand, as soon as this false corpus luteum is absorbed normally or expressed manually by the operating hand of the veterinarian, the phenomenon known as heat invariably develops within 48 to 120 hours and with suitable environment impregnation occurs. This observation has been made so many times by a sufficient number of highly trained, observing, experienced veterinarians, that in the minds of these men, this is no longer a debatable question.

Under normal conditions when there is no opportunity for impregnation, the period of heat in the cow recurs every 21 days and the false corpus luteum is absorbed in about 3 weeks. This last statement is based on the observations of veterinarians, who ordinarily find the ovary, from which the last ripe ovum has escaped, to assume about the normal size at the end of 2 weeks so that by the time the next cycle begins the false corpus luteum has become entirely absorbed. Under abnormal pelvic conditions in the cow, the absorption of the false corpus luteum may be delayed for weeks and even months. The abnormal conditions which seem to prevent the absorption of the corpus luteum, are usually pelvic abscesses, salpingitis, and endometritis, due to an infection caused by the bacillus of Bang. That this is a fact is evidenced by the following: cows suffering from these pathological conditions, due to this infection, often do not come in heat for months and in such cases an examination practically always discloses an unabsorbed corpus luteum in one of the ovaries. If this corpus luteum is manually expressed, the cow invariably comes in heat within 48 to 120 hours, the first requisite to possible impregnation. The possibility to impregnation now, however, depends upon the severity of the pathological changes and the acuteness of the infection. If the infection is relieved, impregnation will take place in the large majority of these cows.

Dr. R. N. Gordon Darby, formerly of Barrington, Illinois, and now of Hackettstown, New Jersey, several years ago took charge of a herd of one hundred high grade Holstein cows, the average value of which was about $400.00 per head. The year before he took charge of this herd only 14 viable calves were produced on this farm. Most of the cows were sterile, a large percentage of them did not come in heat at all, and the others did not conceive, some of them having been bred more than a dozen times without resulting pregnancy. Nearly all of them were infected with the bacillus of Bang and those that did not come in heat had unabsorbed corpus lutea. After the pelvic infection and endometritis had been relieved by irrigating the uterus and vagina with large quantities of Lugol's solution, those that did come in heat quite readily conceived as did also those with unabsorbed false corpus luteum immediately after the corpus luteum had been expressed. The first year following this line of treatment, the number of calves produced on this farm had risen considerably and the second year when the benefits of this dual treatment became fully effective the number of viable calves this herd produced was 86.

Pelvic infections have long been recognized as the cause of sterility in the human female and every operating surgeon with large experience could report many cases where the relief of pelvic infection has made conception possible. I have had a considerable number of patients with premature menopause, who gave the history of having suddenly stopped menstruating because of a severe chilling during menstrual period and who have never menstruated since, and another considerable number of patients, who, following a chilling or a severe illness during a menstrual period, menstruated only at intervals varying from several months to several years, who suffered from the distressing symptoms of artificial menopause. In view of the above experience on the cow, I would today laparotomize such patients, carefully examine the ovaries, and if an unabsorbed corpus luteum were found, excise the same with the hope of relieving the symptoms, re-establishing menstruation, and curing the sterility.

The following case is presented as possibly belonging to this class.

CASE 1. Miss A. N., age 20. Present illness began about 6 weeks ago with severe pain in right lower quadrant of abdomen, pyrexia. Menstruations regular 28-day type, except has not menstruated during past 10 weeks. Tender mass, size of large orange, to the right of the uterus. Uterus fixed. Median laparotomy, appendix cæcum, omentum, loop of small intestine, right tube all involved in a mass around an abscess of right ovary, about the size of a lemon. Adhesions loosened, appendectomy. Right oophorosalpingectomy. Left tube thickened, size of little finger, excised. Left ovary containing false corpus luteum, resected. Patient menstruated 36 hours after operation.

Just why this patient missed two menstrual periods and then began to menstruate 36 hours after the operation I am unable to say, but I believe her case belongs in this general category.

That expression of a retained false corpus luteum will bring on heat in the cow has been demonstrated by veterinarians in literally hundreds of instances. So far as I am able to determine from the literature, the observation that injury, expression, or excision of a false corpus luteum will bring on menstruation in the human female has not been made or at least not emphasized. Rubin[1] in his paper which while he speaks of the inhibitory effects on menstruation of ovarian cysts and gives detailed histories of rupture of false corpus luteum does not state specifically whether such rupture brought on menstruation or not.

Just what relation to the whole sex cycle menstruation bears I have not been able to determine definitely either from my readings or from my own clinical experience. But that menstruation in the human female bears a close relation to heat in the cow is evidenced from the fact that expression of a false corpus luteum from the ovary of a cow will cause heat within 48 to 120 hours in every instance, while expression or excision of the false corpus luteum in the human female causes menstruation in from 12 to 36 hours in every case. Just why menstruation should occur more quickly in woman than heat in the cow when the false corpus luteum has been expressed is not clear. Theoretically one would expect œstrus to precede menstruation and menstruation to be the terminal stage of the sex cycle in those cases where the ovum has not been impregnated. In support of the statement that menstruation invariably occurs within 12 to 36 hours after the expression of false corpus luteum in the human female permit me to report very briefly the essential points in the following nine histories. I have a number of other similar cases but I believe these will suffice to establish this point.

[1] Rubin, I. C. Surg., Gynec. & Obst., 1917, xxvi, 443–453.

CASE 2. Jessie S., age 20. Low medium incision; appendix somewhat inflamed and congested. Both tubes tortuous; thickened to the size of an index finger, closed at distal ends. Left tube adherent surrounding ovary with which it makes a mass the size of a small lemon. Both tubes and left ovary removed. Left ovary contains a false corpus luteum. Last menstrual period began 17 days before operation and persisted for 2 weeks so that she had been clean only 3 days. Twenty-eight day type. Patient began to menstruate 36 hours after operation and 11 days ahead of time.

CASE 3. Mrs. J. A., age 45. Double salpingitis with left ovary and tube adherent to sacrum. Double salpingectomy; portion of left ovary contained a false corpus luteum resected. Menstruation irregular but never too frequent before operation. Began to menstruate 24 hours after resection of ovary though she had been over her last menstrual period only 1 week.

CASE 4. Mrs. A. L., age 35. Low medium laparotomy; loosening of adhesions of mesocolon to former appendix scar. Removal of two filbert-sized fibroids from uterus. Removal of both inflamed tortuous tubes and resection of adherent left ovary containing a false corpus luteum. Began to menstruate 30 hours after operation though previous menstruation had started 12 days before operation and ended 8 days before operation. Her usual menstrual flow 3 or 4 days, of the 26-day type and very regular.

CASE 5. Mrs. S. R., age 30. Low medium incision; appendix inflamed, thickened. Appendectomy. Uterus and both adnexa in a mass in cul-de-sac. Right ovary and both tubes removed. In loosening adhesions about left ovary corpus luteum in same was injured. Patient began to menstruate in 30 hours though her previous menstruation had stopped only 3 days before operation. Regular 28-day type.

CASE 6. Mrs. F. H., age 26. Low medium incision; appendix inflamed and adherent. Patient just over an acute appendicitis; appendectomy. Left ovary adherent: loosened. In doing so, injured false corpus luteum. Menstruated 36 hours after operation.

CASE 7. Mrs. G. E., age 36. For a number of months has complained of severe pain in left lower quadrant about one week after menstrual period. Menstruations regular 28-day type. One week after second last menstruation examined, left tube found considerably enlarged. Present condition,

one week after last menstruation, mass to left of uterus about size of a lemon, painful and tender. Low median laparotomy, appendix embedded in adhesions; removed. Left tube and ovary make a mass about the size of a small lemon, firmly adherent to cul-de-sac. Adhesions loosened, left ovary and tube removed. Patient menstruated 30 hours after operation.

CASE 8. Mrs. M. S., age 23. Menstruation at 17, then no period for about a year. Then menstruated almost continuously for 2 years when she had a laparotomy, removal of left ovary, tumor of uterus and appendix. Well for about two years, then had a sudden profuse vaginal discharge which has kept up ever since. Had another laparotomy 6 months ago when she was informed there was an abscess of the ovary and the uterus fastened up. No relief since, constant pain in right side and back, occasional sick headaches. One abortion 3 years ago, no other pregnancies. Tongue clean, heart and lungs normal, perineum intact, cervix normal, uterus in normal position, freely movable, to right of uterus a fluctuating mass about the size of a small orange. Median incision through former scars. Adhesions of omentum to former abdominal incisions loosened, tears and omentum repaired. Fluctuating tumor about the size of a small orange to the right of the uterus and adherent to it. Apparently a degenerated cystic ovary, removed without rupturing it. Both tubes and left ovary removed at former operations, as was also appendix. Adhesions of appendices epiploicæ loosened and ligated. Wound closed. Patient of 28-day type, regular, last menstruation began 10 days before operation, flow continued for 3 days; began to menstruate again 12 hours after operation. Has not menstruated since, operation being performed on October 1. Examination December 1, result apparently perfect, patient informed states that she had not felt so well in years.

CASE 9. Mrs. A. J. Patient sent to hospital by family physician on November 8 with diagnosis of acute perforated appendix. On bimanual examination a fluctuating mass found to right of uterus and in lower quadrant of abdomen, irregular, lobulated, tense, size of a large orange. Moderate pyrexia, nausea, severe pain. Three days later low median incision, fluctuating lobular tumor of right tube and ovary, each about the size of a lemon. Left ovary and appendix had been excised at a previous operation. Uterus adherent far down in pelvis, adhesions loosened, right tube and ovary removed without rupturing. Temporary ventrosuspension of uterus. Patient regular 28-day type; her last menstruation had begun 15 days before the operation and ended 9 days before the operation. Began to menstruate 30 hours after the operation. Left hospital on the eighteenth day. Wound completely healed, pelvis negative, and general condition excellent.

Just why these two last women should have a typical menstrual flow after the removal of their last remaining ovary can, it seems to me, be explained only on the supposition that in each instance the remaining ovary contained a false corpus luteum and that its removal brought on the menstrual period.

Ordinarily the true corpus luteum is retained in the ovary of the cow from 30 to 70 days after parturition. This statement is based upon the following facts: first, usually the cow does not come in heat for this period after calving; second, the true corpus luteum can be felt by the operating veterinarian on examination for approximately this length of time, and finally, when this true corpus luteum is expressed, the cow will invariably come in heat within 48 to 120 hours. This fact is made use of by veterinarians to get valuable cows to produce a larger number of calves. In this way, a valuable cow can be made to produce a calf every 42 to 44 weeks instead of every 52 weeks, an increase of fecundity of about 20 per cent, which in a cow whose offsprings vary in value from $10,000 to $100,000, is quite an item.

The absorption of the true corpus luteum is delayed in the presence of lactation. Every bright country lad knows that cows that are suckling their calves do not come in heat as quickly as those which are milked and that some cows, as well as mares, will not breed at all while running with their young. This observation is corroborative of the common belief among women that nursing prevents pregnancy in a considerable portion of cases.

Veterinary surgeons have also made another very important discovery. Sometimes in expressing what they considered a false corpus luteum they have actually expressed or ruptured a true corpus luteum, in which instance one of two things has invariably happened, either the cow has bled to death in a very short time or she has aborted within from 24 to 36 hours. This observation on the cow throws very interesting light on the problem of abortion. This experience by veterinary surgeons, as well as my own experience in operating on pregnant women, leads me to believe that abortions following abdominal traumas are caused by injuries to the true corpus luteum and not to traumatism of the uterus itself and that in operating upon a pregnant woman the important precaution

is to avoid traumatism of the ovary containing the true corpus luteum if one wishes to avoid interruption of pregnancy. I have operated on a goodly number of pregnant women in almost every stage of pregnancy for a variety of abdominal conditions, such as intestinal obstructions, hernia, appendicitis, gall-stones, and even fibroids of the uterus, and with the exception of Case 11 herein reported never caused an abortion and I believe this has been possible because I have always been very gentle with the ovaries at the time of such operation, not because I have known the fact that injury of the true corpus luteum would produce abortion, but because I have made it an invariable rule to treat all intra-abdominal organs with the greatest care and consideration.

The following history is a fair illustration of this class of cases.

Case 10. Mrs. E. A., age 25. Chronic intestinal obstruction with acute exacerbation. Low median incision, omentum slightly adherent to old laparotomy scar. A thin band extending from one loop of small intestine across another loop to stump of left broad ligament, making partial obstruction of the bowel. Band ligated double and severed. Uterus size and shape of large bartlett pear, soft and in normal position. Right ovary contains true corpus luteum. Uterus and ovary handled with the greatest gentleness. Patient's last menstruation 60 days ago. Wound closed, patient made an uneventful recovery, no uterine contraction or abortion. Six months later patient in good condition, pregnancy progressing normally, and expects to be delivered in about 2 months.

The tolerance of the pregnant uterus to traumatism was indelibly impressed upon me some years ago. A woman three months pregnant with multiple uterine fibroids, one on the posterior surface of the uterus at the junction of the body and neck insisted upon having an operation She had lost two former pregnancies, one at the fourth month from abortion and the other at the time of birth from craniotomy, because the largest fibroid on the posterior surface of the uterus had made normal delivery impossible. She was very anxious to be the mother of a living child and argued that having failed twice she was willing to take almost any risk to save this pregnancy. The small fibroids on the fundus of the uterus were easily removed but the one on the posterior surface offered great technical difficulty and necessitated considerable traumatism. The patient, however, made an uneventful recovery never having any labor pains nor any uterine bleeding, went on to full term and gave birth to a living child. I firmly believe now that if I had injured the true corpus luteum this fortunate outcome would not have occurred and the resultant abortion would probably have been ascribed to excessive traumatism of the uterus.

The importance of avoiding injury or excision of the true corpus luteum in case of pregnancy is further emphasized by the following two histories.

On April 4, 1919, I made a preliminary report on this subject before the Chicago Surgical Society. Shortly after, I met a colleague, who after greeting me accosted me in the following words: "Your observations on the function of the corpus luteum explains to me now why Mrs. X. aborted," and then gave me the following history: "About 6 years ago I operated on Mrs. X. for an acute appendix. She was 3 months pregnant and I took particular pains not to manipulate, traumatize, or even touch the uterus, but finding what looked to me as an enlarged cystic right ovary, I excised it. The woman aborted in 48 hours."

Case 11. On April 8, 1919, Mrs. J., age 20, came to me for examination, from whose history I take the following essential points: One child one year ago, no miscarriages. Never strong since birth of child, has pain in left side, appetite poor, quite nervous, bowels constipated, nursed baby up to a few days ago. Considerably emaciated. Present weight 98 pounds, one year ago weighed 140 pounds. Tongue thickly coated, perineum somewhat relaxed, uterus in normal position and fairly movable, cervix normal, right adnexa normal, left ovary and tube distinctly enlarged and tender. Laparotomy advised, but patient did not come to the hospital until June 11, or 9 weeks after the first examination. Examination at this time showed no change. Patient was laparotomized the following morning. Appendix was found slightly adherent and constricted and was removed. Left tube enlarged and inflamed, distinct varicocele of left broad ligament, enlarged left ovary containing either a true or a false corpus luteum. Left cophorosalpingectomy. Thirty-six hours after the operation the patient aborted and on careful inquiry it was discovered that she had menstruated only once since the birth of the last child, namely, on May 8 and had missed her menstruation on June 5.

This experience emphasizes two things: that the excision of the true corpus luteum causes abortion and that if a considerable interval intervenes between the first history taking and the operation, the first history should be carefully brought down to date, particularly if the patient is a female of the child-bearing age.

In recent years a number of articles have appeared in the medical journals emphasizing the fact that in many cases of supposed

extra-uterine pregnancy neither the fœtus nor placental tissue can be found on the most careful search. My own experience has been along the lines of these articles. In two such cases in which I made a pre-operation diagnosis of extra-uterine pregnancy I was unable to find anything wrong with either of the tubes in spite of the fact that there was a moderate amount of free blood in the pelvis. I believe now that if I had examined the ovaries more critically I would have found a ruptured false corpus luteum in each case. A number of such observations has actually been made by other operators and I believe that ruptured false corpus luteum with pelvic hæmorrhage and irregular menstruation is much more common and that true, ruptured, extra-uterine pregnancy is less common than heretofore supposed.

The observations of veterinarians on the cow are corroborative in certain respects of the work done by Fraenkel[1] on the rabbit but much more convincing as shedding light on the same problem in the human female because made on a much larger number of cases and on an animal species that has as a rule single, instead of multiple, fœtations and a period of gestations almost identical with that of the human species.

[1] Lippmann's Handbuch der Frauenheilkunde, 1914, vol. iii.

CONCLUSIONS

I believe the above data justify tentatively at least, the following conclusions:

1. That an unabsorbed false corpus luteum prevents ovulation and is a common cause of sterility and that the expression or excision of such a false corpus luteum invariably brings on menstruation.

2. That the excision or rupture of a true corpus luteum invariably results in interruption of pregnancy, at least during the early months of pregnancy, and that it may be looked upon as a common cause of abortion.

3. That an injury to either the true or false corpus luteum may simulate ruptured extra-uterine pregnancy.

PREGNANCY IN A RUDIMENTARY HORN OF THE UTERUS

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MANY cases of pregnancy in double uteri are delivered without surgical interference. In fact only one type of developmental deformity of the uterus is of serious clinical importance to the obstetric surgeon.

Pregnancy occurring in a uterus bicornis unilatere rudimentarius becomes as tragic an accident as can happen to a woman. It would seem, in the light of this fact, that it might be well to refresh our minds as to the occurrence of this predicament, with the hope of more accurate diagnosis and rational treatment.

Embryonal study shows this abnormality to be caused by an initial lack of development during fœtal life of the middle and lower parts of one of the muellerian ducts, with a consequent failure of the two ducts to coalesce, the effect being, to produce a small appendage of uterine tissue connected by a band of fibromuscular tissue, "generally about 1 centimeter in breadth and 3 to 7 centimeters long" (1), to the lower or middle part of the body of a well developed uterus. In a few of the cases a very small canal communicates between the appendage and the uterine body, through the fibromuscular band. In the others, the only opening into the rudimentary horn is through its fallopian tube, which is regularly well developed. The round ligament is attached to the anterior and superior surface of the accessory uterine tissue. It has been observed that this deformity is more likely on the right side than the left, but no known explanation for this has been offered. The well developed uterus is perceptibly displaced from the median line toward its own side of the pelvis. Certain irregularities in the menstrual function are noted in this malformation, but bear no relation to the

subject of this paper except for the likelihood of spotting at the time the menstrual period should occur, in spite of pregnancy.

In 1669, Vassal (3) and Mauricau (4), put the first case of pregnancy in a rudimentary horn on record. Kussmaul (5), of Heidelberg, in 1859, published a classical work on the absence and defects of the uterus, in which he gathered 12 scattered cases of pregnancy in a rudimentary horn. Sanger (6), in 1883, collected 27 cases with a mortality of 88 per cent. Only four of these were treated by laparotomy. Hammelfarb (7), in 1888, brought the total to 34, Sodan (8), in 1898, to 55, Kehrer (9), of Heidelberg, in 1900, to 82, Brooks Wells (10), writing on "Duplication of the Uterus and Vagina," in 1900, pointed out that a more careful microscopical study of the pedicle in these cases will show a minute canal through which impregnation probably occurs from below. Werth (2), in 1901, collected the total to 100 cases and showed that in less than 20 per cent was there a macroscopical canal connecting the horn with the main uterine body. It is of interest to note that of these first 100 cases reported, only 2 were from the United States, Wells' case and one reported by Munde (11). A fairly thorough search of the literature since 1904 contributes 46 (12, 53) more cases including our own 2 cases.

Since the epoch closing with Werth's very complete study of this subject, the cases have been considerably increased without any corresponding gain in knowledge. In that era of study of this subject, it was made the theme for the inaugural address of three of the leading professors of Continental universities. Probably the most that there is to learn about this condition has long since been written, but certain very interesting points remain to be cleared up. There is more work to be done on the mode of impregnation, and on the early diagnosis before rupture.

The generally accepted explanation that the pregnancy is the result of migration of the spermatozoon up through the well developed uterus and its tube, out across the peritoneal cavity, and into the tube of the rudimentary side seems incredible. I agree with Wells that a more careful microscopic study of numerous sections of the pedicle will probably show a minute canal, as his did, about the size of a bristle, lined with columnar epithelium, which is the portal most frequently used by the sperm cell to meet the ovule from the ovary of the rudimentary side, or from the other ovary. This opinion is borne out by recollecting that the muellerian ducts in early fœtal life are solid strands of tissue, which contain in their center a microscopic canal lined with columnar epithelium.

Several cases are on record of the presence of the corpus luteum in the other ovary proving the transperitoneal migration of ovula; and it is not to be denied that in rare cases a fecundated ovum may cross the peritoneal cavity.

It was a failure to realize the importance of a microscopical study of the pedicle in our own cases which leads to this plea for such investigation of all cases that shall present themselves in the future.

Clinically this form of ectopic pregnancy is divided into two distinct classes of cases: The first, by far the more numerous group, in which the pregnancy goes on until the fourth or fifth month and then rupture occurs with terrific abdominal bleeding. In the second class, the hypertrophy of the uterine tissue in the sac is sufficient to allow the pregnancy to continue near to term, with the advent of labor. Ninety per cent of the cases of which I was able to read the reports were in the first class, and 10 per cent in the last. That we may see the entirely different clinical picture in these divisions, I will briefly recite the history of 2 cases which have come under my observation.

CASE 1. Mrs. ——, No. 70,204 was admitted to the Methodist Hospital, October 18, 1918. She gave the following history: married; age 30; white; native of the United States; housewife.

Her chief complaint was terrific abdominal pain, vomiting, and feeling of great distress. The family and past history was negative. Menstrual history, began at 14, regular, 28-day type, not painful. Married 2 years, one previous pregnancy resulting in a 7 months' premature birth, 10 months ago. The child lived 6 weeks. The patient now has been pregnant 4 months; last menstruation June 20, 1918, since which time she spotted at each succeeding menstrual date.

Present illness. While standing at the dinner table at 12 o'clock today, she was taken with severe pain in the lower left quadrant of the abdomen. "She lay down and yelled, then became covered with cold sweat, and then vomited." She soon suffered from air hunger and thirst; called a physician, who ordered her to the hospital. She was removed in a furniture van, no ambulance being available because of the influenza epidemic which was then at its height.

Her physical examination on admission showed a well nourished woman, with an ashen white face, cyanotic lips and fingers, and very anxious expression, calling for water and complaining of smothering, although apparently not in pain. Head examination was negative, lungs clear, apex in the fifth space, very rapid, sounds clear, and of good quality. Pulse 150, poor tension but well sustained. Abdomen, quite distended and tender throughout, no rigidity, although quite resistant to deep pressure; shifting dullness in flanks; no masses to be felt.

Vaginal examination. Tenderness in right and left fornix, especially on movement of cervix, which presented the softness of pregnancy but was closed. The fundus could be made out very indefinitely about the size of a three months' pregnancy. No masses could be felt in the adnexa but a definite resistance was present in the cul-de-sac and in both fornices.

Her blood pressure was 50 over 30, blood count showed 2,150,000 red cells, hæmoglobin 30 per cent.

A provisional diagnosis of ruptured ectopic pregnancy was made.

She was given ⅓ of a grain of morphine hypodermatically and prepared for operation. The bed was placed in Clark's position and in 2 hours the pulse had improved in quality and diminished in frequency from 150 to 120. She was catheterized, and under ether and oxygen anæsthesia a median incision found the abdomen distended with blood, and containing a dead fœtus about 17 centimeters long, which was attached by the cord to a placenta, which in turn was protruding from a rupture in a rudimentary horn on the left side of the uterus. In the rupture and subsequent contraction this portion of the uterus had turned practically inside out.

The horn and left tube and ovary were clamped off and removed. The left round ligament was severed from the horn and attached to the uterus just above the wound. The uterine wound was closed with two layers of sutures, the blood removed from the abdomen, and the abdomen closed by layer suture.

The patient had a sharp reaction, temperature reaching 105° and the pulse going to 180. She was kept morphinized and stimulated with digalen and strychnine.

She improved steadily and was discharged from the hospital on the twentieth day, her blood count then showing 3,576,000 red cells and hæmoglobin 53 per cent.

The specimen showed a typical rudimentary horn about the size of an orange, with a solid muscular band attaching it to the uterus, through which no communication with the uterine cavity could be found. The fallopian tube on that side was patent, and the round ligament was attached to the anterior and outer aspect of the rudimentary horn.

The subsequent history of this case is interesting in that she became pregnant in May, 1919, and went into labor on the evening of January 29, 1920. The shortened broad ligament on the left side held the lower part of the uterus so far to the left that engagement of a breech presentation did not occur, and I delivered her by abdominal cæsarean. In contrast to that clinical picture note this report.

CASE 2. Mrs. ——, No. 75,086, was admitted to the Methodist Hospital, September 25, 1919. She gave the following history: Married two years; 21 years of age; white; native of the United States.

Her chief complaint was labor with convulsions. The family and past history were negative. Menstrual history began at 13, scanty, regular, very painful, 5 days, 28 day type.

Present condition. Last menstruation in December, 1918. She felt life in April, and confinement was due in September, 1919. There is a history of some headache and swelling of the legs, through the latter months of pregnancy. She was under the care of her family doctor. The onset of her present condition was noted on the day of her admission to the hospital, blinding headaches with the advent of convulsions, three occurring before admission to the hospital by ambulance at 1:50 a.m.

Examination on admission showed a stuporous woman at eighth month of pregnancy; heart and lungs negative, in active labor, no fœtal heart sounds. Pelvic measurements showed an ample pelvis; rectal examination showed a cervix very high up and to the left, os admitting two fingers, a presenting part engaging. Her blood pressure was 170–100. A few drops of urine obtained with catheter boiled solid.

The patient was placed on routine eclamptic treatment and as she was in active labor no attempt at immediate delivery was made. On morning round, examination by vagina showed a presenting part, the head, well engaged in the pelvis; but displacing the cervix high up and to the left. The dilatation was only 2 fingers with very little shortening.

The uterus was tonic, no fœtal heart sounds. The baby being dead and not very large it was determined to deliver her at once by vaginal cæsarean section and craniotomy.

She was prepared and moved to the operating room and my associate, H. B. Matthews, started the usual incision of vaginal cæsarean section only

to find in a few moments that he was in the abdominal cavity, the walls of the pregnant uterus being to the right of the split in the cervix.

I opened the abdomen at once and delivered the dead child by abdominal hysterotomy. Then it was noted that there was a tube and ovary on only the right side of the uterus, and in exploring for the other, the unimpregnated, good uterus popped up from behind the pregnant uterus. In palpating the inside of the pregnant uterus we found it to be a cul-de-sac with no canal connecting it with the cervix, and upon enlarging our cæsarean incision in the abdominal wall, we found the band connecting the rudimentary pregnant uterus with the other. The vaginal incision had done so much damage to the small good uterus that it was necessary to do a supracervical hysterectomy. The patient had an uneventful convalescence, without any further eclamptic seizures, and left the hospital in 3 weeks, perfectly well.

In considering the diagnosis of this abnormal pregnancy, the first class is most frequently confused with ordinary tubal pregnancy; the latter group with normal full term pregnancy; and labor with cervical dystocia.

In making the diagnosis in the first class, before rupture, the history will help in that pregnancy has advanced to a considerably further period than would be expected in a tubal pregnancy. Pain begins much later. The spotting, coming from the unimpregnated uterus, is frequently accompanied by pieces of decidua and is likely to be synchronous with the menstrual date. Before rupture, bimanual examination shows much less sensitiveness on movement of the cervix than in the ordinary tubal pregnancy. There is more enlargement of the good uterus and distortion of its cavity. The mass is firm and usually connected to the uterus by a much broader attachment, a deep sulcus being present between the uterus and the pregnant mass.

These cases are sometimes mistaken for pedunculated fibroids, but careful palpation shows the round ligament coming off the anterior surface and the tube and ovary out beyond it.

In the tragic stage the history of the length of the pregnancy gives one his only suggestion, before the abdomen is open, that it may not be an ordinary ruptured tubal pregnancy.

In the full term cases, again the diagnosis may be quite puzzling. The case goes on in labor, with the presenting part dipping well into the brim of the true pelvis; but careful examination shows the cervix off to one side, not dilating, or shortening. A sound inserted into the cervix goes into the small nonpregnant uterus which can be felt to one side by bimanual examination. Abdominal examination shows the uterus early in a tonic spasm causing the death of the fœtus. So rare is this condition that it is no wonder that it is confounded with the more common lesions one is constantly dealing with.

In neither of the 2 cases presented was the diagnosis made before the abdomen was open; and yet I am sure that if I had the above facts firmly in my mind the diagnosis could have been made in both cases.

The treatment, provided the case comes promptly to hand, presents no great difficulty of technique. If, in operating on the abdomen of women in the child-bearing period, the routine examination reveals a rudimentary horn, it should always be removed as a prophylactic precaution. The succulence of the tissues in pregnancy makes the removal of the ruptured horn with its tube and ovary a matter of only a few minutes effort.

At or near full term, abdominal delivery and removal of the impregnated part of the uterus is always indicated since no drainage is obtainable from below. When in the abdomen, it is very easy to mistake these advanced cases for pregnancy in a normal uterus, unless the precaution of looking for both tubes and ovaries is kept in mind, the little normal uterus frequently being entirely hidden behind the pregnant rudimentary horn.

CONCLUSIONS

1. With more careful history and examination, the diagnosis of this condition can usually be made.

2. In all cases of rudimentary cornua of the uterus the pedicle should be examined by serial sections to confirm the presence of a microscopical canal through which impregnation occurs.

3. All rudimentary cornua should be removed so soon as the diagnosis is made.

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SARCOMA OF THE STOMACH

WITH REPORT OF A CASE AND AN ANALYSIS OF 107 CASES OPERATED UPON[1]

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PRIMARY gastric sarcoma is one of the rarest surgical diseases. There is but one example of sarcoma of the stomach in 840 specimens of sarcoma in the Berlin Pathological Institute. Sarcoma was present in only 4 of the 921 cases of gastric cancer operatively and pathologically studied by Smithies. Tilger cites 4 cases in 3,500 sarcomata. It occurred six times in 13,387 necropsies (Hosch). In 27,250 abdominal sections at the Mayo Clinic in 5 years (Masson), there were 8 sarcomata of the stomach, and of 2,067 malignancies of the stomach (1908–1920), 13 proved to be sarcomata, or 1 sarcoma to 159 carcinomata of the stomach.

In 1847, Bruch recorded the first case of gastric sarcoma. Forty years later, Virchow operated on the first patient. In 1900, Fenwick studied 60 cases in the literature and concluded that 53 of them were authentic. Since that time many other cases have been published, the majority being necropsy specimens.

In 1912, Gossett added 16 cases to Zesas's collection and reported them together with his case, making 61. Of this number, 39 were exogastric and 22 were endogastric. Of the latter, 13 were resected, with 5 deaths. Of 3 living, 1 lived 4 years and 1, 6 years. Of the 29 gastrectomies of the exogastric type, there

[1] Presented before the Southern Surgical Association, New Orleans, December 18, 1919.

were 10 deaths, totalling 42 resections, with 15 deaths (35.7 per cent). Eight survivals occurred from 3 months to 7½ years. Three patients were living after endogastric operations, 1, 4, and 6 years respectively.

In 1914, Flebbe was able to collect 157 cases. Those cases based solely on necropsy findings are not included in this paper as they are rather of pathological interest and throw no light on the progress of surgical treatment. I have been able to find in the literature 93 cases of sarcoma of the stomach which came to operation, in addition to 13 unpublished cases at the Mayo Clinic and 1 of my own, making a total of 107 operative cases and a total of 244 authentic cases of primary sarcoma of the stomach. Probably a much larger number has been operated on, reports of which are not now available.

The personal case herewith appended was a leiomyosarcoma. There are two other similar cases in this series and also two cases that are classified as leiomyoma malignum, which for all practical purposes is sarcoma. In fact Balloch, writing on benign tumors of the stomach, quotes Fenwick as follows: "We have not been able to find a single case in the whole literature where a large fibroid tumor of the gastric wall was above suspicion of malignancy."

Sarcoma of the stomach may occur at any age in life. The youngest case was that of Finlayson, a boy of 3½ years and it has been known to occur in a man of 85 (Gosset). Although sarcoma has been thought to be a disease of young life, it more frequently involves the stomach after the fortieth year of life. Of the 107 cases which I was able to collect from the literature, the age was given in 61. The youngest was a boy aged 3½, the oldest a woman aged 74.

AGE INCIDENCE	Cases
Under 10 years	2
Between 10 and 20 years	4
Between 20 and 30 years	3
Between 30 and 40 years	12
Between 40 and 50 years	14
Between 50 and 60 years	12
Between 60 and 70 years	11
Between 70 and 80 years	3

One patient was spoken of as an old man. The sex was given in 66 patients and of these there were 33 females and 33 males. One case gave a history of symptoms coming on shortly after a fall in which she struck the pit of her stomach. One case came on 2 months after receiving a kick in the abdomen by a mule (McWhorter).

The size of the tumor varies within wide limits from the size of a bird's egg to the case reported by Baldy in which the tumor filled the entire abdomen. From a histological standpoint, the tumor may be any one of several varieties. Round-cell, spindle-cell, mixed-cell, lymphosarcoma, myosarcoma, fibrosarcoma, angiosarcoma, and endothelioma (Clendenning). These tumors are apt to undergo degeneration. They may become cystic from hæmorrhage, sometimes calcareous; hyaline and myxomatous changes may also occur. There is some tendency to ulcerate. On the other hand the tumor may show no signs of ulceration but may appear as a smooth or nodular mass. From its gross appearance, the round-cell sarcoma is the type most apt to be mistaken for cancer. It usually infiltrates and most often involves the pyloric end. It rarely produces pyloric stenosis, however, in contradistinction to carcinoma. This type, through infiltration and thickening of the walls of the pyloric portion, sometimes renders the walls of the stomach stiff, depriving the lower half of motility, thereby causing obstructive symptoms. This type of sarcoma seems to be more malignant and to metastasize more rapidly. The spindle-cell sarcoma is apt to be circumscribed and often pedunculated. In its growth it may present itself externally beneath the serosa or internally beneath the mucosa. In the latter instance it may resemble a polyp. These tumors are the type that grow to a very large size. They have been mistaken for an ovarian cyst or a floating kidney, and very readily since in many instances they may produce no gastric symptoms whatever. This type of tumor is slow to metastasize. It is the best type to deal with surgically and offers a far better prognosis than other types. Sarcoma may involve any portion of the stomach; in a few cases the entire stomach was affected. The growth is relatively slow (in one case 3½ years), but may be quite rapid.

"A sarcoma of the stomach may be, according to its cell origin, a leiomyosarcoma, a fibrosarcoma, a lymphosarcoma, or an endothelioma. There is little doubt also that some or many of these so-called large, round-celled sarcomata are of muscular origin" (Ewing). Any one of these, like sarcoma elsewhere, may have either round cells or spindle cells, the former, as is well known, being the most malignant. A lymphosarcoma is most likely to metastasize, whereas an endothelioma is least likely to. A leiomyoma is the slowest growth, but as a rule occurs at a later age than lymphosarcoma or fibrosarcoma. The grafting of sarcoma, whether round or spindle celled, upon leiomyoma of the stomach is, according to Warner, doubtless identical with a similar process in the uterus. Probably neither is malignant in the beginning.

The microscopic diagnosis was given in 76 cases. There were:

12	Spindle-cell sarcomata
17	Lymphosarcomata
8	Round-cell sarcomata
8	Fibrosarcomata
4	Sarcomata (only)
5	Myosarcomata
2	Small round-cell sarcomata
3	Large round-cell sarcomata
2	Leiomyomata (malignant)
2	Leiomyosarcomata
3	Myxosarcomata
4	Mixed-cell sarcomata
1	Cystic sarcoma
1	Angiosarcoma
2	Fuso-cellular sarcomata
1	Hæmangio-endothelioblastoma
1	Myxofibroma

Among these 61 cases the posterior wall was involved sixteen times, the greater curvature ten times, the pylorus gave origin to the tumor in 7 cases, the tumor was diffuse in 8 cases, the lesser curvature was involved seven times, and the anterior wall four times. The fundus was the site of the growth in 2 cases. The entire stomach was involved in 3 cases. The stomach was described as being reduced to a band in one. The greater portion of both sides of the stomach was affected in 1 case. The tumor was described as being near the pylorus in 1 case, and in another the tumor was attached to the stomach omentum and the transverse colon. In one case the pylorus was spoken of as being normal, the tumor involving other portions of the organ.

Sarcoma is said to metastasize in 40 per cent of the cases. In this regard it is not nearly so malignant as carcinoma. It is prone to metastasize in the skin. This feature has been considered of diagnostic significance. However, Leube found a case in which there was carcinoma of the stomach and sarcomatous nodules in the skin. Sarcoma springs from the muscularis and submucosa and not infrequently dissects its way between the mucous and muscular layers. Ulceration may occur through the mucosa. Perforation is apt to occur. This is especially true of the round-cell sarcoma which is said to perforate in 10 per cent of cases. Lymphosarcoma may be a primary or a secondary lesion, or it may be a manifestation of Hodgkin's disease and not primary sarcoma. A stenosed pylorus has been found in about 7 per cent of the cases.

The diagnosis of sarcoma of the stomach before operation is often impossible. There may be no gastric symptoms whatever. This condition, like all other forms of malignancy, produces rapid loss of flesh, anæmia, weakness, and later cachexia. Only an operative diagnosis is possible. Hæmorrhage from the stomach and blood in the stools is a frequent occurrence, especially in the round-cell variety, although in sarcoma as a rule it is not as frequent as in carcinoma. Ulcer of the stomach may be considered, especially if there is a history of indigestion. The rapid wasting may suggest carcinoma. But sarcoma unlike ulcer or carcinoma does not give a long history of dyspepsia and in sarcoma there are less likely to be symptoms of obstruction. There is more apt to be a palpable mass in sarcoma. Vomiting occurred in 20 per cent of the cases. Pain comes early and persists. The tumors are often large. In Cantwell's case the tumor weighed 12 pounds. The pedunculated variety which projects into the lumen of the stomach may produce intermittent obstruction and vomiting. Pain after food may simulate ulcer, but the long history which is so characteristic of gastric ulcer is absent in gastric sarcoma. Benign tumors of the stomach may undergo sarcomatous degeneration. One case report in the literature had had a tumor for years, which was thought to be an ovarian cyst. Operation revealed a sarcoma of the stomach

wall. The tumor must have originally been benign with recent sarcomatous change. However, every palpable mass in the stomach region should rest under the suspicion of malignancy. The rapid development of anæmia and debility, with loss of weight and cachexia, with early, rather severe, and more or less persistent pain in the epigastrium and the absence of any long standing history of dyspepsia, and obstruction (pyloric) is very suggestive of sarcoma. A palpable mass and bloody vomitus together with melæna is all the more suggestive. Vomiting of blood in a young person, with or without severe pain, and a palpable epigastric tumor without obstruction is suggestive of sarcoma. If the tumor mass is large in a middle-aged person and not associated with the usual symptoms of carcinoma of that size, sarcoma should be considered. With the increasing employment of radiography as a routine in stomach disorders, relatively few cases of this condition, as rare as it is, will escape detection as an anatomic lesion requiring operation. This diagnostic means, as in carcinoma, if employed early will be of value and the too well known classical but hopeless advanced symptoms formerly enumerated as diagnostic should not be waited for, but early exploration should be invoked.

Mortality. The outcome was given in 64 cases. Twenty patients are recorded as having died, 3 as having recurrence, and 41 patients recovered and were reported well at varying times after operation, the longest cure being a case of Rupert's, a lymphosarcoma, who lived 7 years. Overton's patient is alive 10 years after operation; Krause's patient 7½ years; Kimpton's 5 years and 10 months, and 1 of Mayo's patients was known to be alive 4 years after operation. This patient had a spindle-celled sarcoma. The other 3 were of the round-celled type.

CASE 8140. Miss R. H., age 17, a school girl, came for vomiting of blood and melæna. There was a history of a very copious gastric hæmorrhage occurring over a year ago and lasting a few days. It was arrested for 2 days, then recurred, and was almost fatal. It was preceded by headache for a month. Blood was noticed in the stools for a week before the vomiting of blood. Three weeks after the hæmorrhage, a small tumor apparently the size of a lemon was noticed in the apex of the epigastrium. It was palpable for about a month and then it could not be made out again. The melæna returned 2 weeks ago and reappeared 1 week before admission and was associated with weakness but never any pain. She was quite pale and very weak.

X-ray examination showed what appeared to be a perforating ulcer of the lesser curvature about the size of a cherry, reported as an extruding defect on the lesser curvature. Hæmoglobin was 40 per cent. Red cells 2,150,000. Blood transfusion was followed in a few days by abdominal section under gas, showing an apparently malignant growth on the lesser curvature, size of a child's fists, bluish, nodular and irregular in size, springing from the stomach with little or no extension to the glands. It was quite favorable for resection.

After a second transfusion, the hæmoglobin rose to 56 per cent and the red cells to 3,000,000. Partial gastrectomy including tumor was performed March 17, 1919, by the Polya precolic method. The postoperative progress was satisfactory for the first few days, when slight vomiting increased, persisted, and became uncontrollable in spite of repeated lavage and continuous proctoclysis, and so forth. By the seventh day vomiting was incessant, prostration was extreme and the general condition critical. There was no evidence of peritonitis. The vomiting was considered as mechanical, and re-operation was reluctantly decided upon. It was obvious that interference would be very hazardous as her pulse had become very weak, and 140; the patient appeared quite desperate. Seven hundred cubic centimeters of citrated blood were given, her pulse came down to 96, and she vomited but once after the transfusion. The hæmoglobin after transfusion was 70, red cells 3,780,000. The plan of re-operation was happily abandoned. The explanation of the vomiting is probably acidosis but the proof is lacking. The vomiting was regarded so certainly as obstructive that the routine examination for acetone was not ordered. The day after transfusion, acetone was absent. The patient made a complete recovery and is now quite well.

Pathologic report by Dr. Rosson. Miss R. H. Date March 23, 1919. Serial No. 2873. Referred by Dr. Haggard. Source of specimen: Tumor from stomach. Time removed: March 17, 1919.

Gross pathology. Specimen consists of a part of the stomach extending from the pyloric region upward for a distance of 10 centimeters along the greater curvature. Attached to the lesser curvature is a soft, nodular, apparently cystic tumor (Fig. 1). The greater portion is dark colored, as though the cystic spaces contained blood. The surface of the tumor also shows adhesions to the serosa of the stomach separate from the main point of attachment. Projecting into the lumen of the stomach are several fairly firm, smooth, nodular masses. A large one blocks the pylorus (Fig. 2). These are covered with mucosa and on section are greyish-red and cellular, resemble thyroid gland on section. The

Fig. 1. Gross specimen of sarcoma of lesser curvature of the stomach.

Fig. 2. Cross section of sarcoma of lesser curvature of the stomach.

mucosa of the stomach shows several small, gelatinous nodules.

Microscopic pathology. Sections were taken from the nodules which projected into the stomach. The mucosa shows no change. The greater portion of the submucosa intervenes between the tumor and the mucosa. The tumor consists of a very cellular tissue with very few definitely formed intercellular fibers (Fig. 3). The cells are principally of the embryonic, connective-tissue type. There are also numerous smooth muscles. There are a few lymphocytes. Some of the connective-tissue cells are oval in shape, others are more spherical. There were only two mitotic figures found. The tumor is evidently not growing rapidly.

Diagnosis. Fibromyosarcoma.

"The sections of tumor of the stomach which you sent me I would interpret as leiomyosarcoma (Fig. 3).

"The tumor tissue is composed of rather small spindle cells with small hyperchromatic nuclei, and cytoplasm which is rather opaque and eosinophile. The cells are arranged irregularly, but in some places they are grouped in small clusters often about a minute blood vessel. This feature is occasionally seen in cellular uterine myomata. The stroma is very scanty except about the outskirts of the tumor. There are no signs of necrosis. I should not expect this tumor to metastasize, nor to recur locally if completely removed, but its cellular character deserves the histological designation as sarcoma" (James Ewing).

Douglas in an excellent review of the subject added 3 personal cases to the former collection of Forni (1914) and Medina and Egana, together with 18 cases from the literature, aggregating 92 operative cases. In addition to these, I have analyzed 13 unpublished cases from the Mayo Clinic (2 of these were quoted by Douglas as reported by Hunt-

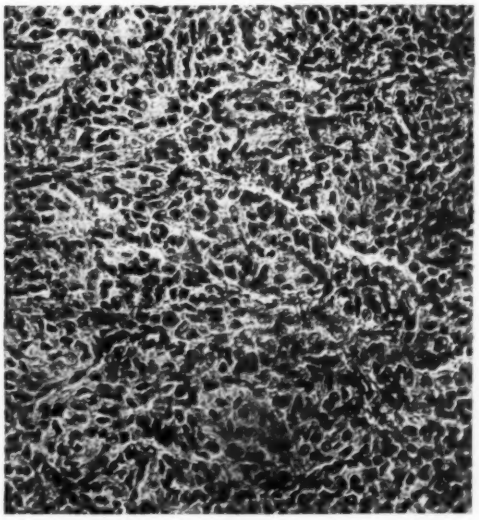

Fig. 3. Microscopic section of sarcoma of lesser curvature of the stomach.

ington, as personal communications) and 1 additional case each by McWhorter, Pagenstecher, Basch and the writer, making a total of 107 patients operated on. Pagenstecher's case was referred to by Douglas as a necropsy, but it appears that an exploratory laparotomy had been done 12 days before death. Of the 107 cases, 80 had partial gastrectomies or resections of the tumor and part of the stomach wall. Twenty-seven had explorations or gastro-enterostomies. Of 58 partial gastrectomies 15 died, a mortality of 25 per cent. Of 10 exploratory operations 8 died in the hospital; 1 was reported to be in poor health after 4 months, and the remaining 1 was not heard from after 2 months.

The 13 cases of sarcoma of the stomach operated on at the Mayo Clinic between 1908 and August, 1920, are herewith briefly abstracted.

CASE 18165. Woman, age 38, had noted an abdominal tumor for the past 3 years. She had nausea and lack of appetite with gaseous eructations for 2 months. She had 3 1-day periods of gastric pain. At operation a tumor 20 centimeters in diameter was found arising from the greater curvature of the stomach. Partial gastrectomy was done and the patient made a good operative recovery. Diagnosis: fibrosarcoma. Patient died 6 months after operation.

CASE 53972. Man, age 62, during a period of 4 years had three attacks of pressure and pain in the epigastrium. Nine months previous to examination he had a 3-days' attack of nausea and vomiting with slight hæmatemesis. At exploratory operation a lesion was found located at the fundus of the stomach and there were extensive metasteses. Small section of the gland was taken for diagnosis. His immediate recovery was good but when last heard from, 4 months after operation, he was in poor condition. Diagnosis: sarcoma.

CASE 82074. Man, age 44, for 4 weeks has had pains in the epigastrium, and had noticed an abdominal tumor for 1 week. At operation a tumor was found involving the greater curvature and also the transverse colon. The origin of the tumor was doubtful. Partial resection of the stomach was done and the patient made a good recovery. Four years later he reported as well. Diagnosis: spindle-cell sarcoma.

CASE 182060. Boy, age 16, for 4 months has had continuous pain in the left side with indigestion and gas an hour after eating. At operation a tumor was found on the posterior wall of the stomach. The tumor was excised. The patient made a good recovery, but has not been heard from since. Diagnosis: lymphosarcoma.

CASE 188936. Man, age 62, for 6 months has had an occasional pain in the epigastrium. Exploration was made for diagnosis and a lesion was found involving the lesser curvature and pyloric end of the stomach. Partial gastrectomy was performed. The patient made a good operative recovery, but has not been heard from since 2 months after operation. Diagnosis: lymphosarcoma.

CASE 204520. Woman, age 44, for 7 years has had annoying epigastric pains with moderate gas eructations. No tumor was found on examination. At operation the posterior wall of the stomach was involved, and a Polya resection was done. Good operative recovery. Diagnosis: myosarcoma.

CASE 205800. Man, age 53, for 30 years has had bloating and indigestion with an exacerbation for 3 weeks previous to examination. No tumor was made out on examination. The pylorus was found to be involved at operation and an anterior Polya resection was done. Good operative recovery, but patient died at the end of 4 months. Diagnosis: lymphosarcoma.

CASE 265434. Man, age 42, for 4 months has had epigastric distress with gas eructations and slight vomiting. At operation the lesser curvature was involved and a subtotal gastrectomy was done. The patient died 3 weeks after operation. Diagnosis: lymphosarcoma with glandular involvement.

CASE 282682. Man, age 66, has gradually weakened for 2 years. He vomited a pint of blood 1 month before operation. He had noticed an abdominal tumor for 1 year. Through the abdominal wall the tumor felt very much like a spleen. At operation the tumor was found originating from the lesser curvature. Partial gastrectomy was done. The patient reported well 9 months after operation. Diagnosis: mixed-cell sarcoma.

CASE 309588. Woman, age 40, had noticed an abdominal tumor for 1 year. For 7 months she has had attacks of abdominal pain, nausea and vomiting; but never any blood in vomitus. A tumor was found involving the pylorus. A partial gastrectomy was performed. The patient made an immediate good recovery. Diagnosis: myosarcoma.

CASE 289467. Woman, age 62, for 8 weeks has had epigastric pain with distention of the epigastrium without gas. She had a poor appetite. At operation a lesion was found involving the lesser curvature and the posterior wall of the stomach. A partial gastrectomy was performed. The patient died 7 days after operation. Diagnosis: lymphosarcoma.

CASE 190100. Man, age 46, complained of pain in the chest with periodic distress in the stomach and occasional vomiting. He had lost 20 pounds. A lesion was found involving the lesser curvature and a partial gastrectomy was performed. The patient recovered. Diagnosis: lymphosarcoma.

CASE 316187. Man, age 47, for 1 year has had gas eructations with gnawing epigastric pain after meals. The lesser curvature was involved. A partial gastrectomy was performed. Recovery. Diagnosis: lymphosarcoma.

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A STUDY OF PERSISTENT BONE SINUSES

Observations from 500 Cases Following Gunshot Wounds[1]

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MANY of us who for any considerable time were engaged in clinical work while in service were privileged to have observation over numbers of cases so large as compared with civil work as to warrant conclusions of a very definite nature. There is a tendency to forget these or to stow them away in the back of the mind as belonging to a chapter now closed. It is true that certain of the problems we met are now only of academic interest or were of a peculiarly unusual nature, such as the gas bacillus infections in France; but there are many others such as the treatment of joint injuries and the experiences with the epidemics in the cantonments that have direct and valuable application in civil work today; and we ought to utilize and spread the information thus gained.

The subject which the writer has assumed of sufficient interest to present lies somewhere between the two extremes of value mentioned. As a title the term "persistent bone infections" has been used. A still better definition would be "bone fistulæ." There are several reasons for avoiding the word osteomyelitis, a sufficient one being that the splendid study of its pathology accomplished by Nichols and the able work of Simmons, Homans, and others on its clinical aspect and surgical treatment make it presumptuous of me to attempt to add to the subject. That suppurative osteomyelitis of civil work is still a discouraging surgical problem is apparent from the fact that the literature is still full of new suggestions for treatment, and therefore more skepticism than interest would be expected at an attempt to add to them. But the observations to be made here concern a process which, as Chutro (1) has pointed out, is inaccurately defined by the term osteo*myelitis*, as the marrow is rarely involved and as it is essentially an *osteitis*, low grade but of such a stubborn character that any success in treating it may carry some lessons for other uses. With the increasing number of industrial accidents, compound fractures which have become septic and under indifferent treatment have maintained a persistent unhealed course may be referred to our larger centers for definitive treatment. Such chronic cases might well be comparable to those to be described and respond in a similar manner to the treatment evolved. Whether ordinary subacute osteomyelitis of hæmatogenous origin can be so approached is an exceedingly interesting question. These lesions are not well walled off and the dangers from systemic absorption following radical treatment are greater. Then, too, the fact that the disease is most frequent in early adolescence before full bony growth is attained certainly urges conservative methods. But, on the other hand, the tendency of many to persistent chronic course with toxic degeneration and amyloid disease would warrant accepting certain definite risks to terminate the process.

During the 12 months subsequent to the armistice, about 500 cases of persistent unhealed bony lesions passed under the writer's observation, and in the last part of this period I was privileged to have control of the operative and after-treatment of all such cases received. About 250 of these were operated upon by the writer or under his direction, and it was possible to follow through to healing an equal number. But as the work was done under trying circumstances, one hospital after another being suddenly abandoned, illustrative and statistical evidence which now would be invaluable could not be preserved. Therefore, this cannot be a strictly scientific presentation; the experiences, methods and conclusions are offered for what they may be worth. The three hospitals concerned were successively Base Hospital, Camp Devens; No. 10 General Hospital and

[1] Read before the Clinical Society of the Massachusetts General Hospital, January 21, 1920.

Fig. 1. Illustrative of a number of high femur lesions in the writer's series, but showing especially the excessive honeycombed callus, a large resorption area in the lesser fragment, and the frequently inevitable union with deformity.

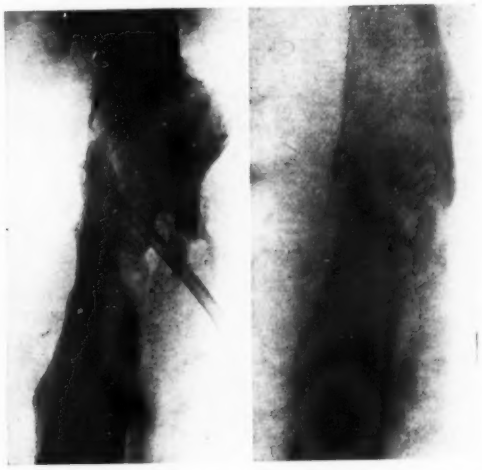

Fig. 2. X-rayed with tube inserted to show direction of sinus. Note common tendency to disintegration of projecting ends of fragments.

Fig. 2a. Same case illustrating excellent result of radical treatment (operated upon by Captain Rice). Note degree to which projecting spicules have been resected.

No. 30 General Hospital. As practically all the patients remaining in the first two were evacuated to the third, many could be followed through a considerable period.

The observations, conclusions, and methods of treatment arrived at, as will be presented below, were obtained wholly by evolution and experiences with the problems offered by this series. Since return to civil life, however, the writer has had opportunity to go over the contemporary literature and finds that others, after struggling with the same problem, have arrived at and set forth similar conclusions. Therefore, this report is not presented as a new suggestion, but as another contribution to the recent trend of opinion on this phase of war surgery.

The one characteristic which all the cases of this series had in common was the existence of an infected bony cavity. Pedro Chutro (1) of Argentine, after a long experience in France with the sequelæ of gunshot wounds, has strongly emphasized these factors of infection in a bony cavity with incollapsible, unregenerative walls. But in the common civil condition of "Brodie's abscess," we have seen an infected bony cavity which, if evacuated and sutured, generally gave no more trouble. Perhaps the avirulent nature of this "albus" infection and the moderate degree of bone sclerosis have made these more amenable to treatment. Martin (2) has recently gone over the subject of persistent bone sinuses as seen in civil work and the attempts previously devised to obliterate them, and is using methods of treatment similar to those of the writer. Leriche believes that the infectious process limits the power of bone to fill the cavity or to provide his *milieu ossifiable* (3). Sargent mentions a case showing a cavity 3 inches long from which, 16 years before, a 4-inch sequestrum had been removed (4).

In the past the integrity of this bony chamber has been accepted, and cure attempted by plugging with various media. In the last 50 years the number of materials of such purpose advocated is almost legion, and includes of absorbable nature, sea-sponge,

Fig. 3. Large sequestrum in cavity in tibia. Rarefaction around smaller shrapnel fragment imbedded in bone. Larger one in soft parts not involved in process.

Fig. 4. Taken after cavity had been cleaned out in conservative operation. Patient was received by the writer 4 months later and showed an almost identical X-ray picture. Surface wound still existed opening into large granulating cavity, fairly clean but showing no tendency to fill in.

Fig. 5. Postoperative picture showing apparently perfect result in a lower femur lesion. The wound sterilized satisfactorily but was allowed to granulate in of itself. Before cicatrization was complete the patient was transferred, became re-infected, and was operated upon two months later by the writer for further sequestrum formation. This time complete healing was secured before evacuation.

catgut, starch and iodoform, and bone chips; and non-absorbable, gypsum, copper-amalgam, gutta percha, various cements and bismuth paste (Beck). That these would be only occasionally successful would seem probable from the evident combination of a foreign body plus infection. Mosetig-Moorhof, in 1903, evolved an exceedingly complicated technique for the injection of a mixture of iodoform, spermaceti, and sesame oil, which would be gradually absorbed. Experimental work on dogs by Silbermach (5) bore out the theory of absorption, but the iodoform content militated against its use in large quantities. Twenty years ago Watson-Cheyne introduced the theory of the obliteration of cavities by the absorption and replacement of blood-clot (6), and advocated its use for such purpose, but the susceptibility of blood clot to infection precluded its use with such attendant complication. Bone-wax as a plugging material following cauterization with pure carbolic acid has been advocated by Cotton (7), but he found its application limited to conditions strictly comparable to a dental cavity with no soft parts involved. Fat, used by Neuber, for filling defects in soft parts, in 1893, was first used in bone by Chaput in 1903. Makas (8) in 1912, and Calforio (9), in 1918, showed that in dogs it was followed by bone regeneration. Rutherford Morison has presented war cases showing this phenomenon, and uses fat transplants extensively for filling defects. He also advocates extensive revision operation followed by impregnation with his "bipp" and closure in one sitting. His technique has not produced the same results in the hands of others and has aroused a great deal of adverse criticism.

Approach to this problem, by conversion of the cavity into an open gutter, has been advocated by Broca, by Sargent (4), by White (10) and by Chalier (11). The method

evolved by the writer, that of an extremely radical revision or ablation operation, by which the disease and its maintaining causes are removed, followed by the application of the Carrel-Dakin technique to prevent reinfection of the newly exposed surfaces and to permit later closure by plastic operation or simple secondary suture, was first advocated by Jacob (12), of Belgium, at the end of 1917, and has since been frequently emphasized by Chutro. The value of the Carrel-Dakin technique as a postoperative aid has been urged in this particular problem by Professor Carrel himself, and by Cotton, Rice, and others on this side and abroad.

GENERAL NATURE OF CASES AND ANTECEDENT COURSE

The patients in this series were all American Expeditionary Force cases received for final disposition in army general hospitals on this side. With a few exceptions they were originally gunshot wounds with compound comminuted fractures. The femur was the bone most often involved, with the tibia very close in frequency; humerus lesions made up a much smaller group, while sinuses leading to the bones of the forearm or to the fibula without involvement of tibia were met with very rarely. This rarity was much below the relative frequency of injuries in this region, but when received on this side lesions of these smaller bones had much more frequently healed. The writer attributes this to more radical methods of early treatment, a factor which will be referred to later. In the series, union was present, either bony or fibrous, save in a small percentage of cases. In fact more patients were received in these hospitals having non-union with healed wounds than with persistent sinuses. The longest period since injury was 24 months; the great majority were between 6 and 18 months' duration; and one patient was wounded only 3 months prior to admission, having been accidently shot in machine-gun practice after the armistice. The analysis of previous treatment was of interest. The number where early and adequate surgical treatment had not been received was very slightly larger than that of those receiving an immediate débridement operation. This apparently surprising result is explained probably by the fact that a far greater proportion of wounded did receive adequate early treatment, and that a considerable number of these became reinfected and subsequently septic during evacuations and transport. In fact the story of almost every soldier bore testimony to the evils of interrupted and

Fig. 6 (at left). X-ray of femur of Pvt. K. showing overriding fracture in soft fibrous callus with sequestrum in lower fragment.

Fig. 6a. Same case after conservative operation indicated because of complicating heart lesion. The wound cleaned up in a satisfactory manner with Carrel after-treatment. The progressive atrophy of the upper fragment is apparent, however, and the necrosis had evidently extended well up into the marrow cavity with possible involvement of the blood supply. Roentgenogram was taken May 5. In July the wound had developed a definitely purulent discharge and X-ray then showed sequestration of the lower 3 inches of atrophied cortex. The patient's condition was otherwise much improved, and the necessity of facing a loss of continuity being accepted, radical operation was performed by the writer. A small amount of the lower fragment had to be removed and about 3 inches of upper resected. The fragments were kept apart and pocketing prevented by traction. After 2 weeks of Carrel treatment the bone ends had disappeared under firm granulations and another 2 weeks found the wound clinically sterile. As it was filling in with great rapidity, suture was unnecessary. Of course a graft was ultimately required.

inco-ordinated methods of treatment and the dangers of repeated evacuation of compound fractures while still in the unhealed state. Many gave a story of operation with excellent subsequent progress, rapid contracture of the wound and diminution of the discharge followed by transportation and consequent local flare-up, with prolonged fever, sepsis and emergency drainage operation; and this course often had been many times repeated. The number of previous operations directed at the bony focus in no case was less than two and in many as great as 8 or 10. Postoperative treatment included the use of every known antiseptic. Dakin's solution accompanied by an alleged Carrel technique had been tried at least once in every case. It was interesting to note the rather canny appreciation of methods of surgical aftercare acquired by the more intelligent patients, and their observations on the variety of application of common methods.

PATHOLOGY AND ETIOLOGY

The most striking fact about the pathology of these lesions was the large size of the callus produced. It varied somewhat with the degree of comminution and displacement, and often had a diameter three times that of the original shaft. There was in addition extensive dense cicatrices of the soft parts from the original and operative wounds down to the callus, and one or more draining sinuses. The functional disturbance was necessarily great and steadily increasing, muscles being tied down and joints stiffened by disuse or by the progressive muscular fibrosis. Where joints were movable, attempts at functional improvement or increased motion were almost always followed by a local flare-up at the site of infection.

An anatomical arrangement of the varieties of fractures shows two groups with two types in each. Taking the fractures of the diaphysis as the first group, we found a considerable number with a fracture more or less transverse, in fair alignment, a small callus of great density, an advanced degree of osteosclerosis of the neighboring shaft obliterating the medullary cavity in either fragment, and a sinus leading to a small chamber in the center, containing a sequestrum less frequently than the second group, but perpetuated rather by the inability of the sclerosed walls to generate any healthy tissue, bony or granular. The more common type in this group presented a break spiral and comminuted with some degree of overriding or mal-position. This was held together by a huge callus, osteofibrous or spongy with fungosities, containing multiple chambers with continually reforming sequestra, following their disintegration and discharge in small pieces through the sinus. The sequestra were frequently very large, several inches long, forming a long fissure in the shaft, or originating from fragments of the shaft which had been left *in situ* at the first operation. The function of these original, partly detached fragments as an etiological factor in the disease will be referred to later. Another constant observation was the tendency to absorption and necrosis with sequestration of the projecting pointed ends of the shaft where alignment was poor.

The second group included the lesions of the epiphysis, and for its first type had fractures not extending into the joint. This type showed very little bone reaction or new bone production, and a tendency to rarefaction and degeneration of the whole epiphysis, which became spongy and fungoid, containing many small soft sequestra. The other type differed principally in having a persistent communication with the joint, which although ankylosed, seldom had progressed to complete destruction of the cartilage, a necrotic remnant remaining to perpetuate the sinus and the infectious process. This peculiarity of cartilage to persistent necrosis until its total extent is destroyed or removed was observed also in infection of the costal cartilages. The joint cases referred to were the most stubborn and recurrent type met and required the most radical operative treatment for a cure.

Persistent sinuses in the presence of nonunion made up a very small group. These few showed a very soft fibrous callus, a tendency to mushrooming of the bone ends, necrosis and suppuration often extending into the marrow cavity with attendant severe septic complications. A definite relative increase in the amount of atrophy and degenera-

tion in the shorter fragment was regularly observed, which corresponds with Chutro's theory of the defective nutrition of a shorter fragment following fracture.

Lesions of the carpus and tarsus resulting in bone fistulæ were met but infrequently; but these cases almost always progressed until all the articulating surfaces were completely destroyed and bony ankylosis was obtained. After this stage they showed a tendency to spontaneous healing, or were amenable to ordinary surgical treatment. Exceptions were noted in lesions of the tarsus which had resulted in the formation of a very large osseous mass of fused bones having a central necrotic chamber; but even these responded readily to the technique to be described.

ETIOLOGY

In the etiology of these conditions, two groups of factors should be considered.

1. Initial, comprising trauma, infection, and the presence of foreign bodies. In the term "foreign bodies" the writer has in mind not only the original projectile and débris carried into the wound, and secondary projectiles of small bone spicules driven into the soft parts and forming foci of infection in the eventual callus; but includes also the larger intervening fragments in comminuted fractures, in regard to which the teaching has always been insistent to leave in place as aids to union. In almost every case in this series resulting from a badly comminuted fracture, there was found at operation a sequestrum centrally located and by its nature evidently a piece of the original shaft. While engaged in the early treatment of this type of case in France n 1916, the writer followed the customary practice of leaving in place such larger fragments between the bone ends, but at the same time used to wonder what was really their ultimate fate in the unfavorable surroundings of prolonged infection. That these fragments may have a very definite effect in bridging a gap and promoting osteogenesis will not be denied; but in the writer's experience the complications of delayed union or even of non-union in conjunction with the excellent results obtained by bone grafting are not to be compared with the protracted convalescence, the functional disturbance and disability, and the dangers of sepsis resulting from the maintenance of these foci of suppuration. The writer accordingly recommends removal at the original operation of all fragments of bone not supplied with both endosteum and periosteum.

2. Eventual factors, which are the most important in connection with the treatment of condition, consisting of bony cavity plus infection. The cavity, its walls rigid and non-collapsible, is perpetuated by the results of the infection, which causes the osteosclerosis in the walls, preventing bone regeneration and following the support of only a thin layer of unhealthy granulations.

The bacteriology of these cases can readily be conceived. A most varied flora was regularly found. Saprophytic contamination, proteus and pyocyaneous, were common. Staphylococcus aureus was almost invariably present and the predominating organism; but a few cases were seen which had refused to heal and which showed only a feeble albus growth from the bony cavity. Short chain streptococci were fairly common and without especial significance; but the history of flare-ups with high fever often led to the suspicion and discovery before operation of the streptococcus hæmolyticus, necessitating appropriate safeguards.

DIAGNOSIS

The diagnosis of the underlying pathology in these conditions could often be made upon a superficial local examination. The presence of a discharging sinus, with the introduction of probe followed by copious oozing of venous blood was always very significant. Often cheesy bone could be felt with the probe, and sometimes the telltale sequestrum. Cases showing dried-up sinuses but with a history of repeated previous remissions followed by local pain, heat, swelling and fever and by return of discharge in the same or other old sinuses, could almost always be depended upon to recur or to show still existent pathology by X-ray. While roentgenograms, especially stereoscopic, were found invaluable in locating bony cavities and sequestra and planning the scope of operative intervention,

negative plates could not be taken as final and had to be interpreted in connection with clinical findings; extensive sclerosis often made difficult the X-ray demonstration of deep-seated cavities. Assistance was sometimes obtained from plates made with a Carrel tube or a small rubber catheter worked into the end of the sinus. This procedure was usually more valuable than the introduction of a si ver probe or of an opaque paste.

METHODS OF TREATMENT

Before being privileged to take charge of the treatment of all cases of unhealed wounds at General Hospital 30, the writer was associated with the work on this problem in several other hospitals, where it was possible to observe the results of various other methods, with a large number of these earlier patients also later coming under the writer's charge; and about half of the cases upon which these observations are based were seen in this earlier period.

Many different methods of operative and postoperative treatment were used with varying results. Simple curettage of the tract and packing with gauze gave even more unsatisfactory results than in civil work, suppuration increasing with the cavity only a little larger than before. This same operative procedure followed by instillation of Dakin's fluid brought a rapid cleaning up of the discharge and filling in of the wound in the soft parts; but the bony cavity with a narrow tract leading into it persisted indefinitely in spite of the antiseptic treatment, and as soon as this was discontinued suppuration recurred. Staining of the affected tissues by injections of methylene blue followed by radical débridement operation was also attempted; when these were closed by immediate suture a dangerously septic wound resulted with inevitable restoration of the bony pathology; when the wound was left open the septic reaction was much less and the wound soon appeared to be granulating cleanly, but later an area of exposed bone would invariably be discovered or unhealthy granulations covering a low grade but persistent bone infection. The antiseptics of every-day use and dichloramine-T also were less useful as postoperative aids than Dakin's solution, but for good results with the latter exact Carrel technique was found essential. The best results in healing up these bone fistulæ were observed at the hands of Cotton and Rice, of Boston, who practiced a fairly extensive cleaning out operation followed by careful Carrel-Dakin sterilization. They were able to get complete cicatrization in a majority of their cases, the time required being from 4 to 8 weeks. Clinical sterilization of the wound was rarely obtained, however, until cicatrization was nearly complete, and for this reason secondary suture was seldom practiced. The necessity of rapid sterilization and prompt closure of the wound was impressed on the writer on receiving many promising cases of their series that had relapsed with recurring bone sinuses. But even with their careful methods a number of the deep seated bony lesions failed to clear up satisfactorily. However, these methods gave the best results observed, and the writer's technique was based on these principles with the modification of a more extensive revision operation removing every possibility of cavity formation and a lowing rapid sterilization with early closure. The other contributing factors permitting more satisfactory results from the eventual technique consist probably in a number of minor details referred to below, which altogether were found to have a very considerable effect on the ultimate cure.

DETAILS OF AUTHOR'S TECHNIQUE

Lessons from a rather extensive operative experience led to the adoption of certain preoperative measures as an essential part of the routine. Sinuses were dilated, under gas if necessary, adequate tube drainage secured, and mechanical cleansing of the tract by daily irrigations for several days prior to operation. If the patient had shown a recent flare-up with fever, poultices were applied. In the face of an extensive operation often unavoidably opening up unprotected fields, this preliminary treatment was found highly important in preventing severe septic postoperative reactions. Where there had been extensive cellulitis or lymphangitis, the bacterial flora was examined and a streptococcus infection met by preliminary drainage opera-

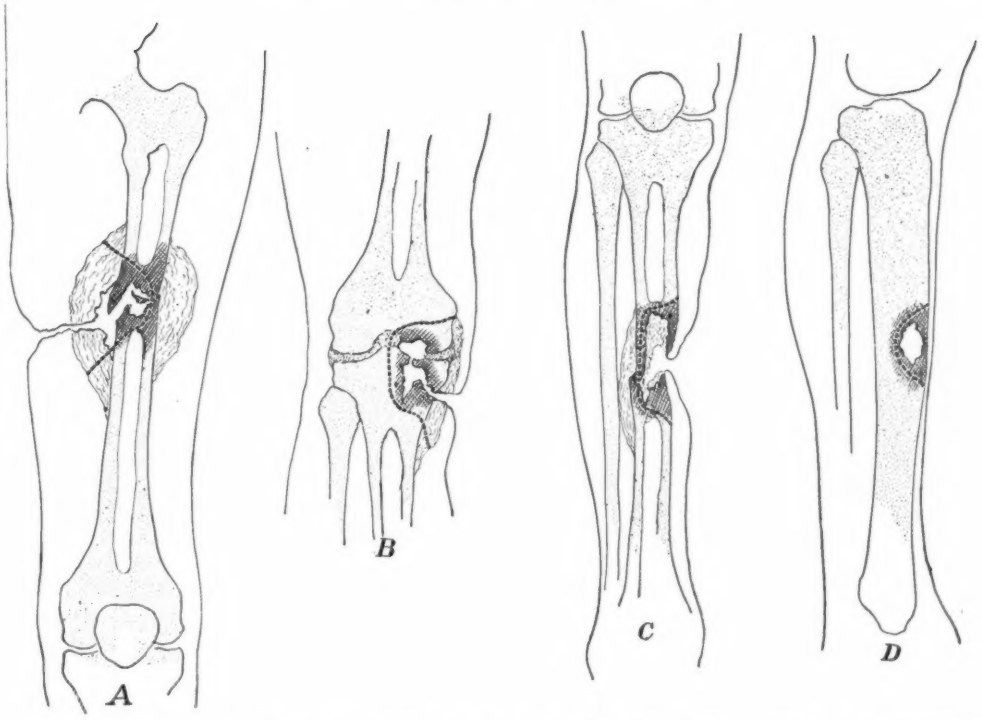

Fig. 7. *a*, Schematic drawing to show common type of fracture with slight displacement, large callus, central cavity with sequestrum, absorption of spicule, and sinus to surface. Dotted line indicates extent of bony excision. Shading represents sclerosis around cavity cutting off medulla. *b*, Illustrates old T fractured tibia with ankylosis. Cavity in head of tibia communicates with pocket at site; unabsorbed cartilage in joint. Excised along dotted line. *c*, Common type of cavity undermining cortex of tibia and line of excision. *d*, Incomplete fracture from seton wound and through-and-through sinus in bony tunnel in crest of tibia. Persistently recurred until converted into groove as outlined.

tion and localizing measures. Occasionally cases are met that are extremely bad operative risks, anæmic and toxic from long continued septic absorption, and with little improvement in general condition following any operative measure short of complete removal of the diseased area. For these the writer wishes particularly to emphasize the importance of transfusion of blood, not after, but prior to operation. The only fatality in this series, a high femur lesion, could probably have been avoided if transfusion had been done *before* operation. The usefulness of this measure in dealing with sepsis has been recognized by other operators, and "straight" blood seems to be more efficacious than citrated.

An attempt was always made to determine the approach and general procedure by careful study of stereoscopic roentgenograms in conjunction with the clinical aspect of the wound. Thus the incision would not always be through the existing sinus but often through an older scar, if better accessibility could be obtained in that way; and on certain occasions it was found advantageous to approach through an entirely new field. Operation was rarely done under a tourniquet, and the writer is distinctly opposed to the use of one. Shutting off the blood supply certainly makes operating much easier and more enjoyable, for the diffuse and persistent oozing from the old scar tissue is highly exasperating. The only argument in favor is

that the dry field makes possible neater and more accurate work; on the other hand, the operation is rarely a brief one and the prolonged ischæmia distinctly lowers the resistance of the muscles to the spread of infection from the septic field. Furthermore, the application of a tourniquet even for a brief time is followed by the relaxation and dilation of the entire arterial system distal to that point; this vascular stasis and hyperæmia persists for some time after removal of the constriction, and a tremendous oozing and often considerable hæmorrhage occurs in the wound hours after operation. The well known problem of the "wet stump" illustrates the difficulty in dealing with this condition, and that removing the tourniquet before the end of the operation is not sufficient. In addition the oozing forms a serious obstacle to the prophylactic use of Dakin's solution as will be shown below. As patience and experience make it possible to overcome the handicap of a wet field, this difficulty should certainly be faced.

In the technique of the writer, the sinus and a small amount of surrounding scar tissue was first excised *en bloc*. The extent of the bone cavity thus exposed was determined, sequestra removed, and the area well cleaned out. So far no normal tissue has been exposed and all the grossly infected material has been removed. The extent of the revision procedure having been determined upon, linen and instruments are changed, and a long incision is made well beyond the furthest limits of the bony cavity. The old scars were usually very extensive, and the writer prefered not to remove them completely until the closure operation, rather keeping within their limits, but excising enough to leave the wound gaping. The incision is carried down to and through the periosteum, the latter being then reflected and the overlying tissues retracted *en masse*, great care being taken to avoid opening into them beyond the protecting wall of scar. The importance of this small detail cannot be too strongly emphasized, as neglect of it has always been followed by cellulitis, prolonged suppuration and sloughing, and frequent reinfection of the exposed bone. With an osteotome the bone not only overlying the cavity but also completely surrounding it is removed. This must be extensive and loss of continuity must be accepted if necessary, although the large callus usually makes this avoidable. Tunnels must be converted into gutters with sloping walls; "well" or bottle-shaped cavities into shallow basins. The excision must continue not only until all necrotic bone has been removed, but also until healthy bleeding bone is reached. The dense sclerotic bone surrounding these cavities has no power of regeneration and insufficient blood supply to support a covering layer of granulations that will protect against eburnation. In irregular fractures fissures forming a nidus or harboring a minute sequestrum should be looked for and eradicated. Finally the bony surface must be made smooth and free from spicules or sharp corners, which are always slow to cover. Definite bleeding points may be tied and complete hæmostasis secured by prolonged irrigation with hot saline and a few minutes' packing. Further trimming of the soft parts may be necessary to complete a careful "toilette."

We now have a wide open wound from which all diseased tissue has been removed. But being accomplished in a septic field, organisms are still present in considerable numbers and no immediate antiseptic will kill them without at the same time damaging the body tissues also. However, the infection is a surface one and the tissues have a natural defensive mechanism against it. The Carrel-Dakin technique was found to be the best method of making these efforts successful. The excellent work of Fleming (13) has indicated that the success is due more to the physiological than to the antiseptic effects of the solution; but the method was found to make sterilization and successful secondary suture possible more uniformly than any other. Scrupulous attention to certain details, however, was found to be essential. In the first place, instillation tubes must be carefully placed and irrigation begun at once, in order that the required action be secured before invasion of the susceptible tissues by the bacteria on the surface has taken place. This requires complete hæmostasis for two

reasons: one that clotting takes place very slowly in the presence of Dakin's solution and oozing will continue often for days, with bleeding from a considerable vessel occasionally occurring some time after operation; the other that the presence of blood and serum in the wound destroys the bactericidal properties of the solution. In addition the formation of a clot adherent to bone surface will protect underlying organisms from the bactericidal action of both antiseptic and normal wound exudate. Chutro has frequently observed bone infection occurring under the protection of blood clot. The action of the solution in removing a certain inevitable accumulation of blood and serum is a further indication for early instillation. Packing with gauze should be minimal and only sufficient to hold the tubes in place. Wound margins may be caught back with sutures or wedged apart by interrupted rolls of gauze. Immobilization of the part is indicated without regard to bony union and metal splints are far more preferable than plaster.

The dressing, save for change of outer pads, is not disturbed for 48 hours. A rise of one or two degrees of temperature always occurs during this period, but the rise of temperature is a ways in inverse proportion to the care at operation in keeping within the walled-off area in the soft tissues and avoiding fresh lymphatic channels. At the end of this time the tissues are much less sensitive and if the skin incision has been protected by vaseline so that the gauze packing will not become adherent a "gas" dressing will not be necessary. The packing is removed, the wound irrigated and margins thoroughly cleaned, but tubes are not removed unless m'splaced or clogged. Daily dressings follow with the most careful aseptic technique, and a bacterial count of the wound secretions is made every second day. Careful inspection and toilette of the wound at each dressing will greatly accelerate the sterilization.

At the risk of tediousness space has been given to emphasis of these details only because in the considerable experience of the writer the consistent application of each of them has been followed by consecutively better results. Clinical sterilization often was reduced to 10 days, although deep-seated lesions of the femur sometimes required as long as four weeks. About 10 per cent developed bone areas which refused to cover up and a bacterial count graph coming to a horizontal just above the base line. These failures without exception the writer attributes to timidity in the operative measures, and second operation was invariably successful.

SECONDARY SUTURE

In the writer's opinion the best criterion as to the value of the technique outlined above lay in the results from secondary suture. For two reasons it has been found essential to do this: first because the maintenance of clinical sterility until cicatrization completes itself is not always possible and can be accomplished only at the expense of an amount of painstaking care and effort not readily available under the conditions at hand; and second because cicatrization by this method results in a prolonged convalescence and a limitation of function which ought to be avoided. Accordingly the wounds were closed as soon as the count fell below an average of one bacterium per field, with the additional criterion that all bone surface must be covered.

It was observed that the end-result of these bone lesions healing in the ordinary manner showed a tremendous functional handicap in the mass of scar tissue extending from the skin into the bone, binding down the muscles and promoting fibrosis thereof. Accordingly in closing these wounds the writer gave up the method of Carrel of simply bringing the wound edges together, in favor of that of Chutro. In this technique all scar tissue is completely excised down to the periosteum, so that normal muscle and fat alone appear in the wound. The skin and subcutaneous tissues are then freed sufficiently far on each side to allow approximation without tension; parallel incisions at the sides of the limb or a skin plastic are sometimes necessary. Then comes the most important step in the technique, reconstruction of the wound to eliminate any dead space. A flap of muscle or a pedicled fat transplant from under the wound margins was found to serve equally well. Free fat

grafts were less successful and were given up. The wound was then closed in layers with approximation of muscle planes, superficial fascia, and skin. The result was a nonadherent linear scar presenting no obstacle to return of muscle function. This method occasionally was not completely applicable from scarcity of soft tissues around the wound, due to atrophy or in situation around the ankle or foot. Extensive loss of skin here would have to be met by a two-stage plastic from the other leg, but where the integument could be easily brought together successful closures were obtained by filling the cavity with "bipp." In most of these plastic operations a rubber dam or capillary drain of silkworm-gut was left in the lower angle of the wound for 48 hours to evacuate serum or broken down blood clot. As no bone work was done at this final operation a general anæsthetic was almost never given, novocaine locally being used without difficulty. A first intention wound was the usual result being obtained in about 80 per cent; complete failure to close the wound occurred but rarely.

That so extensive an operation of wound reconstruction was possible on the site of recent persistent suppuration seems to the writer the best testimony as to the foregoing procedure. The system as outlined from the beginning is essentially that practiced by Chutro, who in a series of 300 operations had only five unsuccessful cases. But that time alone can show the end-result is evidenced by the fact that one of Chutro's successful cases relapsed several months after being discharged cured, and came under the writer's care with a persistent bone sinus and sequestra present at operation; and a similar course may have occurred in some of the cases from which these observations have been drawn.

SUMMARY

1. In the year following the Armistice about 500 cases of persistent bone sinuses following gunshot wounds came under observation for varying periods of time.

2. These had presented an unusually stubborn surgical problem and in spite of prolonged surgical treatment little progress was being made toward a cure.

3. The writer was privileged to have the control of the operative and postoperative treatment of about half of these, and during this experience evolved a procedure, also independently arrived at by others, which led to the clinical cure of the great majority.

4. It was found that the presence of an infected bony cavity was the essential cause; that a revision operation sufficiently radical entirely to eliminate this faulty configuration was the first step required; that the concomitant infection could be effectively controlled and terminated in a comparatively brief time by careful wound treatment based on physiological and antiseptic grounds.

5. It thereby became possible, as well as desirable from the functional standpoint, to close these wounds by a bold reconstruction operation.

CONCLUSIONS

1. Persistent bone sinuses are a very common and a very serious complication of gun-shot wounds producing compound, comminuted fractures, unusually resistant to ordinary surgical treatment.

2. A system of operative and postoperative procedure directed against the underlying etiological factors has been devised after considerable experience which in a high percentage produces a clinical cure.

3. Such a method must stand the further test of late results before it can be regarded as the means of permanent cure in every case.

NOTE.—Having no access to any roentgenograms of the cases in this series, the writer is able to illustrate the nature of the lesions by the accompanying X-rays only through the courtesy of Dr. F. J. Cotton (formerly Major, M.C., U. S. A.) with whom he was associated in the early part of this work, and who has very kindly loaned these prints of similar cases from his own service. Cases 4, 5, and 6 subsequently came under the writer's care for further treatment, as noted.

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ABDOMINAL PREGNANCY WITH FŒTUS ALIVE AT TIME OF OPERATION

With Résumé of Cases

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IN the following résumé of cases of abdominal pregnancy, only those in which the fœtus was living at the time of operation are considered. Discussion is not limited to cases in which the fœtus was viable, because in some the patients were less than 7 months pregnant; and yet, because the fœtus was alive, the operator was confronted with the problem of dealing with a placenta with a still active circulation. Herein lies the difficulty met with in treating cases of abdominal pregnancy.

I have had no cases fulfilling the above requirements. My experience with abdominal pregnancy has been limited to 2 cases in both of which the fœtus was dead at the time of operation.

When the placental circulation has ceased and the fœtus is dead, the operator encounters no greater difficulty than peeling placenta and membranes from adherent viscera. The only alternative is to close the abdomen after removing the fœtus and leave placenta and membranes to be taken care of by the peritoneum. In view of the low mortality attending removal, such a step would, I take it, hardly be looked upon as a legitimate surgical procedure.

In Surgery, Gynecology and Obstetrics, for July and December, 1913, Horsley reported 46 cases from 1897 to the time of writing his article, but his reports are so abbreviated that 14 give only the fate of the mother and child while the balance are deficient in one or more points which are considered in this résumé. However, the cases reported by Horsley are made use of here where possible.

The cases collected for me, 29 in number, were reported during the period from the beginning of 1909 to the end of 1918, and, excluding Horsley's comprised all the cases to be found in the Chicago libraries. There are a number of references in the *Index Medicus* which were not available on account of war conditions or because the journals are not to be found in Chicago libraries, but the majority of them are cases operated upon after death of the child.

My list, therefore, is not a complete one, but in view of the fact that one man's experience with this condition is usually limited to one case, the number is sufficiently large to warrant the drawing of conclusions.

Diagnosis. In 29 cases the pre-operative diagnosis was made in 18, or 62 plus per cent. This compares favorably with the pre-operative diagnosis made in ectopics at the time of primary rupture which, according to an average of estimates, is about 50 per cent. It is, of course, highly desirable that ectopic pregnancy should be recognized and operated upon at the time of primary rupture as, only by so doing, may the number of advanced abdominal pregnancies be reduced to a minimum. If it is true that 50 per cent of ectopics are not recognized at the time of rupture, our methods of teaching this subject to students are at least open to criticism.

Mortality of mother and child. Of 73 cases operated upon, 55 mothers recovered and 18 died, a mortality of 24.6 per cent. In Harris' tables published in Kelly's *Operative Gynecology* the maternal mortality in the 40 cases operated upon between 1889 and 1896 was 32 per cent, so that there is but little improvement in results. Maternal mortality was, in nearly every case, due to hæmorrhage, sepsis, or both. In addition to these causes one mother died from embolism, one from pneumonia, and one, on the ninth day, from shock following operation for intestinal obstruction.

In 59 cases in which the child was of viable age, 27 died within a period of 3 or 4 days, an infant mortality of 45.7 per cent. In the 40 cases quoted above from Harris' table the infant mortality was 45 per cent.

In many of the case records the condition of the child was not stated but in 16 it was stated that the child was deformed, usually

some form of talipes. Subtracting 13 cases in which the child was under 7 months, if all the remaining cases in which the child's condition was not stated were perfect, there were 26.6 per cent deformed to a greater or less extent. The deformities must not be taken as meaning that these children were imperfect in development but rather that the deformity was the result of pressure from the restricted space in which they existed.

Symptoms. In 29 cases abstracted in full, 8 gave a history of primary rupture; 26.9 per cent. In 15 cases there was no history of primary rupture and in 6 the records were doubtful.

Considering the fact that while primary abdominal pregnancy may exist, it is quite rare, and therefore that practically all cases must undergo tubal rupture or tubal abortion, it would seem that these figures are rather less than one would expect. On the other hand, when one remembers the number of cases undiagnosed or wrongly diagnosed at the time of primary rupture, they do not seem so far wrong. Be that as it may, the fact remains that a careful consideration of abnormal conditions which probably existed during the first 3 months of the pregnancy should throw some light on the diagnosis.

Polak comments upon the large number of mothers showing evidences of toxæmia. In over 80 per cent of cases, pain was the most prominent symptom. It was variously described as "colicy" or "paroxysmal abdominal pain" with nausea and vomiting and the attacks were followed by faintness and syncope. In nearly half the cases there was irregular bleeding from the uterus, the amount in some cases being very slight, while in others the amount was such as to be described as hæmorrhage. In one case menstruation recurred regularly up to the time of operation, which was done in the sixth month. In other cases there was "syncope," "fainting spells," "abdominal crises," "peritoneal irritation," "dysuria," and "frequent micturation."

Placenta. In most cases, as would be expected, the placenta was attached to the pelvic organs: uterus, broad ligaments, tubes, pelvic wall, small intestines, and sigmoid. In two cases it was attached to the liver. In several there was a pedicle-like arrangement and the placenta could be ligated as a pedicled ovarian cyst is ligated. The latter arrangement presents the least difficulties for the operator and the greatest safety to the patient. Next in safety are the cases in which the placenta can be removed together with the structures to which it is attached, removing the placenta without detaching it. The disposition of the placenta was stated in 45 cases: in 30 it was removed with a mortality of 10 per cent; in 15 cases it was left or partially removed, with a mortality of 40 per cent.

This speaks strongly for the removal of the placenta but cases doubtless recovered without removal which would have died with removal.

Size of uterus. This was stated in only a few cases: in 6 cases operated upon at term it was variously described as "very much enlarged," "to umbilicus," "size of 3 months' pregnancy," "double the normal size," "somewhat larger and softer than normal," and "size of a 2½ months' pregnancy." One at the seventh month was "markedly enlarged" and one at the sixth month "the size of an adult fist."

From this one would conclude that the uterus is variable in size, probably depending upon the attachments and blood supply.

Treatment. From a perusal of the histories of cases of abdominal pregnancy, they may be divided into three classes: first, those in whom the pregnancy is, while not normal, so nearly so that they do not consult a physician, or, if they do, their condition is not recognized until after spurious labor with failure of the woman to deliver herself; second, those in whom the condition is recognized but whose complaints are of minor importance and who, if let alone, will probably go on to term without serious mishap; third, those who are impelled by constant pain, attacks of syncope, hæmorrhage or toxæmia, etc., to consult a physician and who need immediate operative interference if they are to be given a chance to survive.

Those in Class 1 are probably in the majority but as they do not come for treatment until after the death of the child, they are not discussed in this paper. Suffice it to

say that they come for operation at the most favorable time so far as saving the mother is concerned. Class 3 comes next in point of numbers. In other words, most of them who consult a physician do so for some serious condition. There can be no question but that operation must be done at once. It is not a question of shall the operation be done but rather a question of shall the placenta be removed after the child is abstracted from the abdomen.

It seems to be the concensus of opinion of the medical profession that all cases of abdominal pregnancy should be operated upon if possible during the life of the fœtus, and this brings us to a consideration of Class 2; the few cases in which the diagnosis of abdominal pregnancy has been made but in which the mother's condition is not jeopardized by the complications enumerated in Class 3. Since the mortality from operation after the death of the fœtus is very much less than from operation during the life of the fœtus, it would seem that operation during the latter period must be based entirely on the hope of saving the child.

This, however, is not the case, because abdominal pregnancy is a potential source of great danger, and a grave crisis may arise at any time demanding immediate operation, and this fact must be taken into consideration in determining whether the operation should be done at once or later.

It has also been pointed out that the farther a woman is from term, the greater are her chances of developing serious complications. In other words, complications are greater in the first half than in the second half of the pregnancy.

It would seem a fair deduction that if cases in Class 2 are seen before 7½ months they should, in the interest of the mother, be operated upon, but if seen after that time, *provided they can be kept under close observation*, it would be in the interest of the mother to defer operation until after death of child.

Removal of the placenta. This is a question which must be decided by the operator on the merits of the individual case. Those cases in which the placenta has been removed have given a maternal mortality of 10 per cent against 40 per cent in which the placenta was not removed. I do not take these figures to mean that the placenta must be removed but that a most careful examination, having in view the feasibility of removing the placenta, must be made and the placenta removed, if there is a fair chance of controlling the blood supply.

If a pedicle-like arrangement exists, the removal is simple. If the placenta grows from organs which can be removed, no separation of the placenta should be made but placenta and organs removed *en masse*. The greatest difficulties are encountered in those cases in which the placenta has developed on the liver, the mesentery, or is plastered on the pelvic wall. These are the cases which tax one's judgment in deciding for or against removal and tax also one's ingenuity in controlling hæmorrhage.

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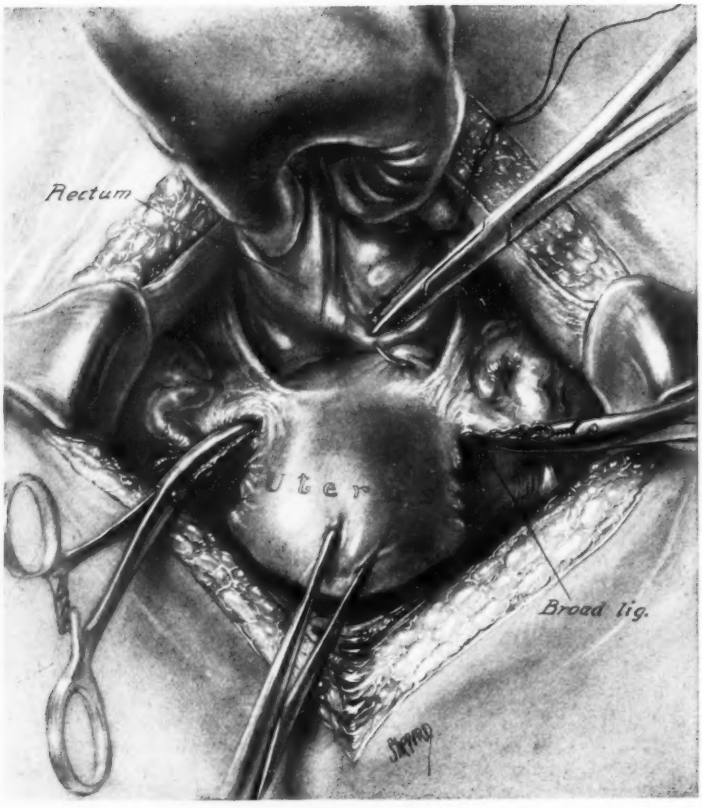


Fig. 1. Broad ligament clamped and severed at both sides of uterus. Rectum pulled forward and sutured to cervical ends of vagina and uterus obliterating cul-de-sac of Douglas.

(*A New Operation for Prolapse of the Rectum in Women.—H. M. Richter.*)

DEPARTMENT OF TECHNIQUE

A NEW OPERATION FOR PROLAPSE OF THE RECTUM IN WOMEN

By H. M. RICHTER, M.D., F.A.C.S., Chicago

THE results of operation for complete prolapse of the rectum are notoriously unsatisfactory. Neither amputation of the prolapsed section, a most illogical procedure, nor intra-abdominal fixation of the rectum and lower sigmoid have proved satisfactory.

The following operation applies to a limited number of cases, but where it can be used, offers, I believe, a fair degree of permanency of result. The operation is limited to women in whom the broad ligaments and uterus can be utilized for the suspension, and must either be performed after the childbearing period is passed or where sterilization is permissible. The essential features of the operation are: first, the suspension of the rectum by passing the broad ligament behind it; second, the fixation of the rectum to the uterus and of the uterus outside the abdominal fascia.

A free medium incision is made, the uterus drawn well forward and the broad ligaments, including the round ligament and the tube, severed close to its side. With the hand introduced deeply into the pelvis, the rectum is drawn taut. It will usually be found that a considerable mesorectum is present, and that the prolapse can be completely reduced by this traction. The cul-de-sac of Douglas is obliterated by suturing the anterior surface of the rectum to the posterior surface of the vagina and cervical end of the uterus, reaching well up on to the posterior surface of the uterus, but not up to its free border. During the placing of the sutures the traction on the uterus is somewhat relaxed. The mesorectum is now outlined as low down as possible. Whether well formed or incomplete, it is perforated carefully by means of blunt dissection, making an opening an inch or more in length, and as near the anal end as feasible. Either of the broad ligaments is now drawn through this opening to be sutured to its fellow of the opposite side, thus forming a suspensory hammock.

To obliterate the pelvic space as far as possible, and so prevent the descent of small bowel, is probably desirable. For this purpose the loose peritoneum is closed in. Particularly, the uterosacral ligaments are sutured to the rectum, and the free border of the broad ligaments to the

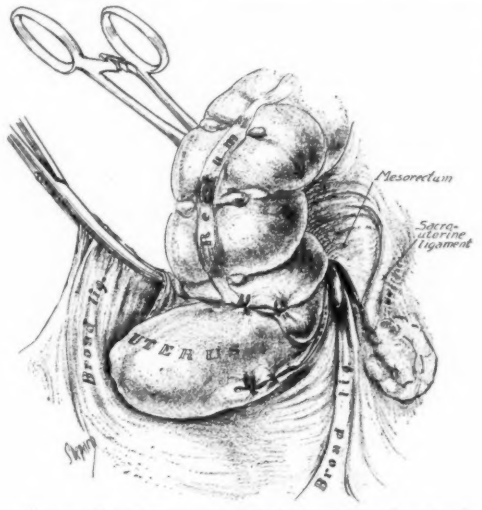


Fig. 2. Broad ligament pulled through perforation in mesorectum.

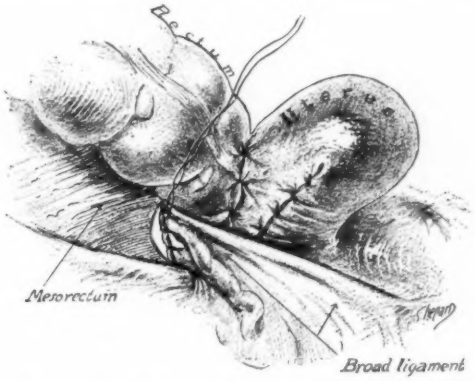


Fig. 3. Broad ligament sutured to its fellow of the opposite side, the latter drawn through the mesorectum.

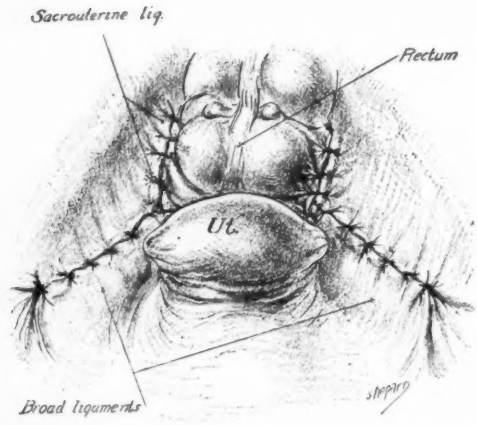


Fig. 4. Sacro-uterine ligaments sutured to sides of rectum. Free edges of broad ligaments sutured to posterior pelvis.

posterior pelvic peritoneum. It is now found that the pelvic cavity is partially obliterated, and that the rectum passes upward and forward, terminating in the lower sigmoid. The free borders of the abdominal fascia are now dissected well back from the skin and subcutaneous fat, leaving the external surfaces exposed. This dissection is carried out only in the lower portion of the incision. The free border of the fascia is sutured to the cervix on each side of the uterus, and the latter further sutured to the anterior surface of the fascia, making a firm, extrafascial fixation of the uterus. As the rectum leaves the uterus, it is further sutured for a distance of an inch or more to the free edges of the abdominal fascia. The closure of the incision is now completed in the usual manner.

It is probable that the recurrence of ptosis, following plastic operations on the various viscera, is due to the inability of peritoneal union to withstand strain or tension. Thus, after the most extensive suturing of rectum and sigmoid to the pelvic and abdominal wall, recurrence is exceedingly common. The fixation of the rectum to

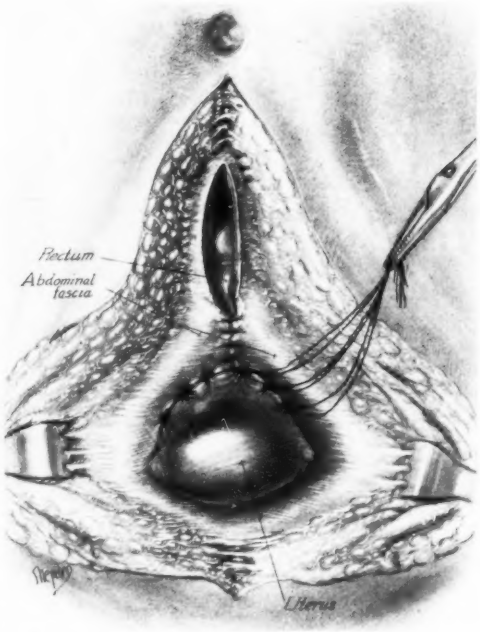


Fig. 5. Uterus and rectum sutured to free border of abdominal fascia, the uterine fundus being extrafascial. The skin will be sutured over the fundus.

vagina, uterus, and abdominal wall is of but moderate value, the permanency of its fixation probably being increased by combining with it the suspension of the uterus. The use of the broad ligaments, however, is, I believe, of considerable value, and the further obliteration of the pelvic space a desirable adjunct.

In a patient, on whom I have recently carried out this operation, the immediate result has been perfect, there being not the slightest bulging. Rectal examination shows the lumen to be snug. The sphincter, which was greatly relaxed by several years of overstretching by the prolapsed mass, was at first entirely functionless, but soon regained its tone.

THE VALUE OF POSITION IN THE OPERATIVE TREATMENT OF INGUINAL HERNIA[1]

By HENRY H. M. LYLE, M.D., F.A.C.S., New York City
Assistant Professor of Surgery, Cornell Medical College; Attending Surgeon, St. Luke's Hospital

THE object of this paper is to describe a simple procedure which will be found of value in the treatment ot inguinal hernia.

For a moment let us rapidly review the muscular and fascial structures which are directly encountered in the repair of an inguinal hernia. Poupart's ligament, formed from the lowest fibers of the external oblique, passes from the anterior superior spine of the ilium to the spine of the pubes. The ligament is curved, with its concavity downward, due to the attachment of the iliac portion of the fascia lata. The degree of curvature and tension of this ligament varies with the position of the limb and body. Extension and eversion of the limb increase the tension; flexion and inversion relax it. The fibers of the external oblique and transversalis that unite to form the conjoint tendon arise respectively from the outer half and the outer third of Poupart's ligament. A relaxation of Poupart's ligament automatically loosens the conjoint tendon and results in an approximation of these structures; the relaxation of the conjoint tendon in turn relaxes the related portion of the rectus.

For convenience we will divide hernial operations into two stages. The first stage consists of the dissection, high ligation, and fixation of the sac: the second stage consists of the transplantation of the cord and the repair of the inguinal canal. The stage of dissection requires a position which will give exposure and definition to the parts; the stage of repair a position which gives relaxation and allows approximation of the structures. The dissection is carried on with the patient in the customary dorsal position (Figs. 1a and 2). On completion of this stage the patient is placed in a position of relaxation with the limb flexed and rotated inward (Figs. 1b and 3). This relaxes Poupart's ligament and reduces the distance between the ligament and the conjoint tendon. The reduction in distance varies in different patients from 20 per cent to 70 per

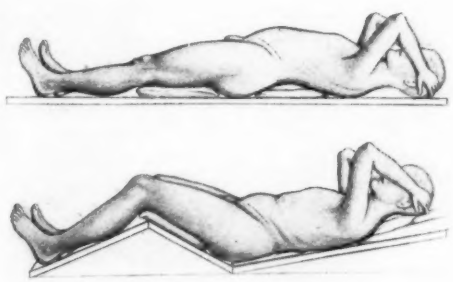


Fig. 1a (above). Position during the stage of dissection and the insertion of the sutures between Poupart's ligament and the conjoint tendon. The requisite of this position is exposure.

Fig. 1b. Position during the stage of repair. Here relaxation is desired. The thigh and knee are flexed and the whole limb rotated inward. This relaxes Poupart's ligament, the conjoint tendon with its component parts, and, to a lesser degree, the rectus. Additional relaxation is obtained by elevating the shoulders. When the maximum physiological relaxation has been obtained the sutures are tied. (In the drawing the arms are raised in order to show the operative field; in practice they are by the side.)

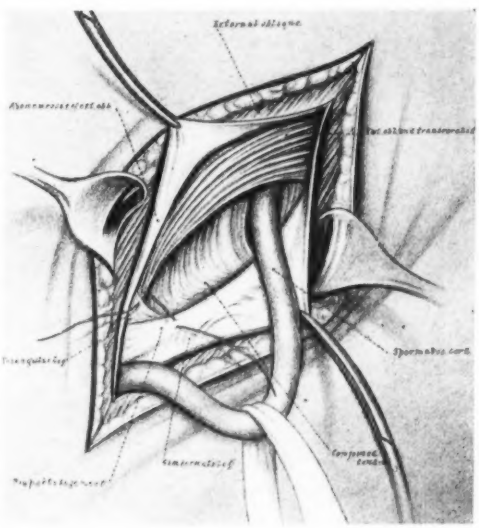


Fig. 2. The stage of dissection is finished and the sutures are being inserted between the conjoint tendon and Poupart's ligament. Note wide gap between the conjoint tendon and Poupart's ligament, and the tension of the internal oblique.

[1]Read before the Surgical Section of the New York State Medical Society, New York, March 24, 1920.

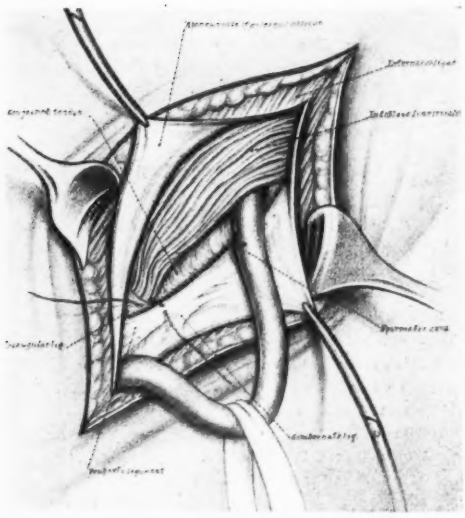


Fig. 3. Same as Figure 2, with the patient in the position of maximum physiological relaxation. Note the automatic approximation of the structures. The reduction of the gap varies in different patients from 20 per cent to 70 per cent, the average being 35 per cent. In the slighter herniæ there is an actual approximation of Poupart's and the conjoint tendon.

cent, the average being 35 per cent. The approachment of these parts is further facilitated by raising the head and shoulders of the patient, which relaxes the rectus and the abdominal wall. In the slighter forms of hernia the gap is almost obliterated. In hernial operations done under local anæsthesia this position aids in combating muscular tension.

We have employed this position of muscular balance for 10 years. During the last 5 years, we have found it necessary to perform the transplantation of the rectus only once. To insure relaxation during the period of healing, the position is maintained for at least 7 days (Fig. 4).

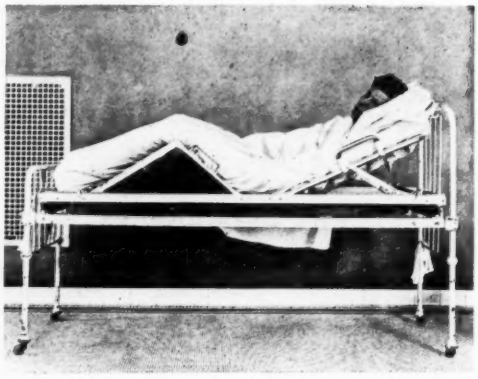


Fig. 4. Post-operative position. The patient leaves the operating room with a pillow under the thigh, and the shoulders elevated. He is transferred to the bed, and maintained in the relaxed position for at least 7 days.

Not so very long ago it was the custom of a well-known clinic to immobilize their post-operative herniæ in plaster spicas. No more barbarous or unphysiological position could be devised; yet one still encounters warm advocates of this folly.

SUMMARY

In order to insure firm union, all tension must be avoided. Tight suturing means tissue tension, impairment of nutrition, and the possibility of a replacement fibrosis. In the operative treatment of inguinal hernia this elementary procedure of placing the parts in a position of muscular rest simplifies the closure, aids union, and insures a comfortable convalescence.

INFLATION OF THE COLON AS AN AID IN ROENTGEN EXAMINATION

By HERMAN B. PHILIPS, M.D., New York City
Roentgenologist, Hospital for Deformities and Joint Diseases

A PATIENT on the dispensary service of Henry W. Frauenthal, appeared at the clinic suffering from chronic arthritis of the shoulder. In the course of a routine examination, a large tumor, apparently of the left kidney, was noted. It was diagnosed as a hypernephroma, and referred to the X-ray department for further examination.

The roentgenograms resulting from the usual examination of the urinary tract, were unsatisfactory, due to the immense size of the tumor. Its borders blended with the shadows of the spleen, liver, and pelvis, and it was exceedingly difficult to make out the margins of the growth. Oxygen inflation of the peritoneum was thought of but not resorted to because of the reluctance of the patient to stay over in the hospital for a few days, and his absolute refusal to be subjected to any operative procedure no matter how slight.

The following technique was used, a method frequently used in physical examinations, and in roentgen examinations of the bladder, but as far as the author can determine, not described as utilized in roentgen examination of the abdomen proper. The patient was placed on his left side, and a rectal tube inserted into the colon. With a small hand bicycle pump, the colon was slowly and gradually distended to the degree of slight discomfort, when the tube was withdrawn. The roentgen examination was then repeated with very gratifying results. The distended and slightly displaced colon offered a contrasting background, which clearly outlined the tumor, as well as the other solid abdominal viscera.

Roentgenogram of hypernephroma after inflation of colon with air.

This method certainly does not offer as universal an application as oxygen inflation of the peritoneum, however its expedience, freedom from dangers and inconveniences, makes the author feel justified in submitting it to the profession at large.

DESCRIPTION OF A SUPRAPUBIC PROSTATIC RETRACTOR

By ROBERT EMMETT FARR, M.D., F.A.C.S., Minneapolis, Minnesota

THE first manipulation of a surgeon when doing a suprapubic prostatectomy is to place one, or more often two, fingers of one hand in the rectum in order to aid the enucleating finger of the other. There is no question but that asepsis is more easily preserved and the technique of the operation more refined when the rectal manipulation is eliminated. In addition to this factor, the rectal dilatation markedly interferes with a smooth anæsthesia. If general anæsthesia is used, a deeper narcosis is necessary upon dilating the sphincter. Under local anæsthesia, the introduction of the fingers into the rectum is a serious handicap.

The instrument which I have devised will effectually do all and even more than the rectal finger can do, thus eliminating the necessity of the latter.

The prostatic retractor, closed (Fig. 1), is introduced into the internal urethra for a distance depending upon the approximate size of the prostate. The prongs are then opened (Fig. 2).

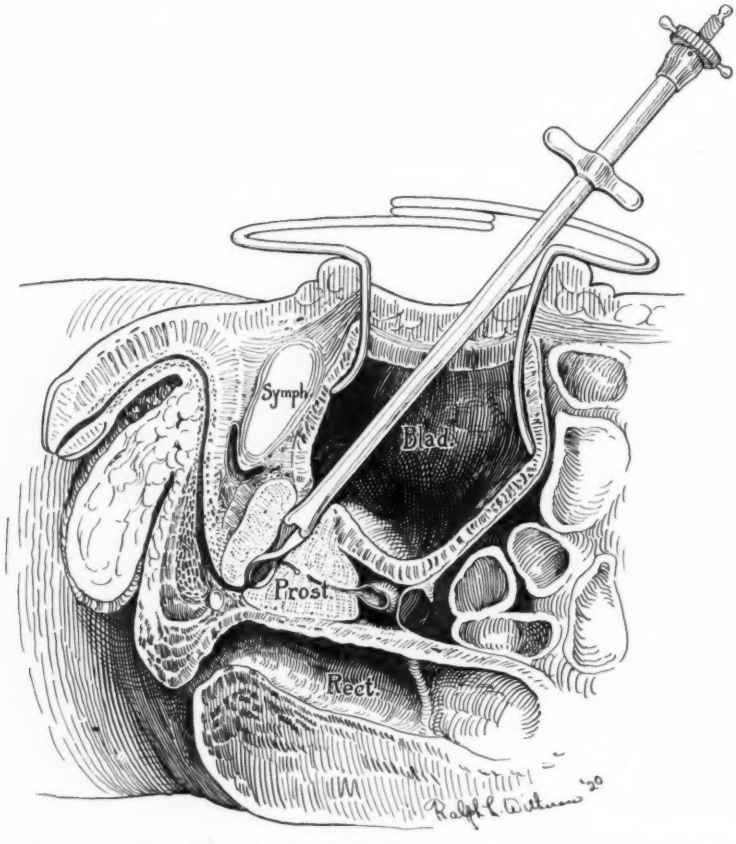


Fig. 1. Sagittal section showing suprapubic prostatic retractor (closed) introduced into the internal urethra.

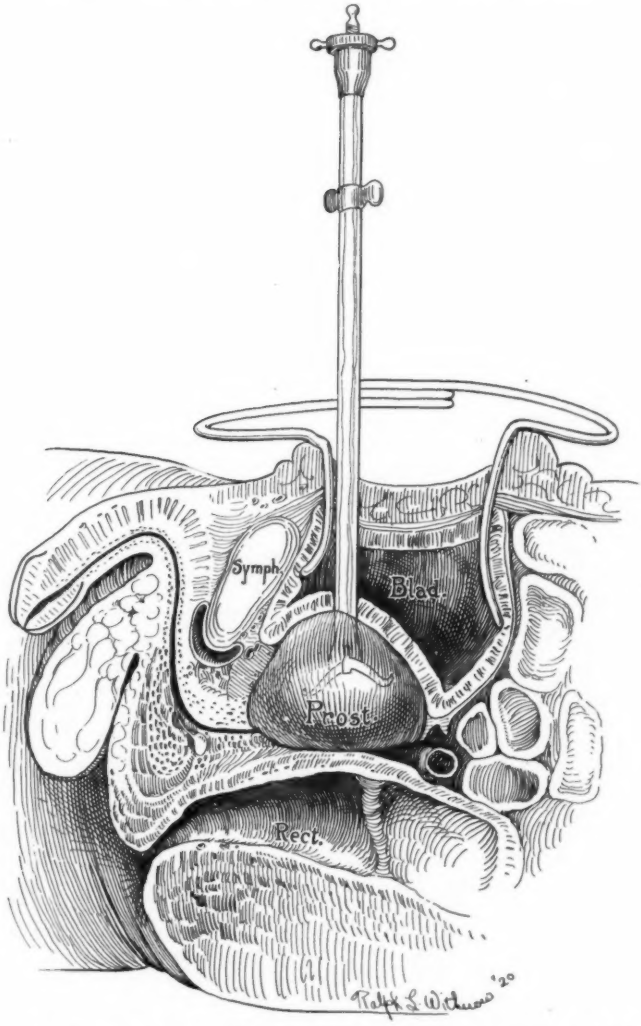


Fig. 2. Sagittal section showing suprapubic prostatic retractor (open) in use. (Note elevation of prostate.)

taking hold in the gland tissue, by turning the circular top of the instrument.

The accompanying illustrations (Fig. 1 and Fig. 2) demonstrate clearly the *modus operandi* of the retractor. With it in place, the prostate may be elevated to any degree that is compatible with its mobility, and the enucleation can be made largely under direct vision. Scissors dissection, done directly under the eye, may be advantageously used to expose one-half or two-thirds of the gland, after which the remaining portion may be freed by the enucleating finger.

Further experience may show that the prongs of the instrument may need to be modified as regards their size and shape. However, the first model has proved very satisfactory in my hands and has greatly facilitated my operations which have been done entirely under local anæsthesia.

TREATMENT OF PROCIDENTIA IN THE NULLIPAROUS[1]

By GEORGE ERETY SHOEMAKER, M.D., F.A.C.S., Philadelphia
Gynecologist, Presbyterian Hospital

THE writer has notes of eight cases showing various degrees of prolapsus of the uterus in nulliparous women, which have been treated by various methods.

Vaginal hysterectomy alone was done in two instances, single women, one aged 57, the other 70. The protrusion of a small thumb-like cervix, without hypertrophy, for an inch and a half, without much descent of vaginal walls rendered this method desirable. Both have had entire comfort since, one for 2 years, the other for 7. Both had had suspicious bleeding previously.

Another patient had a cervical cone dissected out, shortening the uterus to 2 inches. Suspension followed. This was not permanently successful. The patient was a young colored woman, laborer, and should have had hysterectomy, which was refused. Another had amputation of the cervix and supravaginal hysterectomy with suspension of the stump. This patient had a small fibroma and remains well. Two were treated by plastic methods with success, being mild types. Another, with a protrusion of an inch or more of cervix had been married 4 years and was very anxious for children. She had a polypus removed and wore a pessary which corrected the sterility and made her comfortable.

I wish particularly, however, to speak of the method of dealing with the extreme development of the condition where the whole small uterus with bladder comes out, inverting the vagina either completely or nearly so.

In this condition in one instance the writer has failed of permanent success by the ordinary methods which are applied in multiparæ and has been obliged to resort to hysterectomy. In multiparæ the perineal injury is contributory and at operation the normal muscular and fascial relations can be restored for support. In the congenitally defective patient, however, the vaginal walls and connective tissues slide upon one another without the occurrence of gaping of the vagina and there is no injury to repair. This may be illustrated by the following case.

R. McG., age 28, single, was referred by her physician in 1907 for a disabling prolapsus of the uterus, vagina, and portions of the bladder. The protrusion had been complete for 5 months when on the feet. Menstruation was normal. She had never been pregnant according to the history and there were no marks to indicate that it had ever occurred. The vagina was small, smooth, and straight.

The operations performed on this the first occasion were: resection of the long, thin cervix, removing 1½ inches, the uterine canal having measured 4½ inches; radial suture of the cervix; extensive resection of anterior vaginal wall, suture in layers; perineal tightening; abdomen opened; round ligaments shortened by doubling and suture; suspension of fundus by silk sutures.

Twelve years later, that is in 1919, she reported that as the result of the former operations she was well for 4 years, when recurrence took place. Her work as a laundress involved heavy downward pressure on a foot lever and for 8 months the condition had been again disabling. There was a small hydronephrosis on the left side. The mass protruding from the vagina included the bladder and the elongated cervix, the canal again measuring 4½ inches. The fundus of the uterus could be brought down to the outlet. The vaginal tissues were indurated, greatly hypertrophied, and excoriated. Inversion of the vagina was almost complete, only a small sulcus being present behind the protrusion. The condition resembled the ordinary complete protrusion of the parts seen in severe, neglected cases in multiparæ. It was certain that pregnancy had never occurred.

As conservative measures had failed, and as the patient was 40, with her consent, hysterectomy was done with overlapping and suture of the stumps of the broad ligaments in the vagina, attaching them also under the pubic arch. Such a method has been described by Charles Mayo. This gave good support of the bladder and upper portion of the canal but had no effect on the sliding hernia of the vaginal walls and connective tissue. As there was no lacerated perineum to repair and so gain support, obliteration of the vagina was undertaken, after healing and contractions had occurred. Leaving a narrow strip of mucous membrane under the urethra, the edges were turned in and sutured to form a tiny short vagina. The entire vaginal wall was then dissected downward and removed at the outlet. Sutures of catgut were placed in layers to approximate the walls of the cavity from side to side, completely obliterating it.

When seen 3 months later, she was entirely comfortable, and perfectly supported. A canal under the urethra was an inch deep and would admit a pencil.

[1] Read before the Philadelphia Obstetrical Society, March 2, 1920.

CORRESPONDENCE

TRACHELOPLASTY FOR CHRONIC ENDOCERVICITIS

To the Editor: Dr. H. Koster, of Brooklyn, N. Y., in a letter appearing in the September issue, comments as follows: "Theoretically, tracheloplasty as advocated and practiced by Sturmdorf would seem to be the logical form of treatment;" but, "clinical evidence substantiates the experimental indications that the operation does not do what is claimed for it, for many cases followed at the Polhemus Memorial Clinic, even after long continued postoperative local treatment, continue to have symptoms referable only to the continued presence of chronic endocervicitis and the accompanying cellular tissue inflammation."

In my book on *Gynoplastic Technology*, to which Dr. Koster refers, I insist upon the radical enucleation of the "*entire* endocervical mucosa *from the external to the internal os.*" If Dr. Koster subjected his patients to such a radical enucleation, how can he substantiate a "*continued presence of chronic endocervicitis* in many cases"; surely there can be no endocervicitis in the absence of endocervical tissue.

Here lies the crux of the whole procedure. Furthermore, presuming that Dr. Koster did remove the entire endocervical mucosa and secured a union of the inverted cylindrical vaginal flap, to what tissue did he apply the "long-continued postoperative treatment"?

Dr. Koster bases the "clinical evidence" of his failure to cure, as well as his statement that "the operation does not do what is claimed for it" upon the following "experimental indications."

"In undoubted cases of chronic endocervicitis, after having removed a cone-shaped wedge containing the endocervical mucosa after the technique of Sturmdorf, a piece of tissue from the new canal wall was excised, before relining with the mobilized vaginal cuff. This, upon section and staining, showed glandular elements and surrounding inflammatory reaction similar to the tissue removed in the cone-shaped wedge. Repeated confirmation of the results strongly suggests that (a) a mere removal of the endocervical mucosa does not remove all the infective material; (b) that it is impossible to determine, macroscopically, the limiting point of extension of infection in the direction of, and into the cervical musculature; and (c) that in some instances it is impossible to remove all the infective material without the musculature in which it is embedded."

Dr. Koster's observation that the tissues of the new canal wall show "surrounding inflammatory reaction similar to the tissue removed in the cone-shaped wedge," is perfectly correct and may be found fully illustrated in the chapter on "Endocervical Pathology" of my book, but his deductions are entirely superficial and fallacious.

Without entering into a lengthy polemic upon the pathological course of progressive infections in mucous membranes, it will suffice to restate the general surgical axiom: eradicate the infectious focus and the concomitant tissue reactions will eradicate themselves. I do not claim 100 per cent cures, but my experience during a period of over ten years in public and private service, corroborated by that of many operators in different centers, all tends to controvert Dr. Koster's conclusions.

New York City. ARNOLD STURMDORF, M.D.

VIENNA PHYSICIANS DESTITUTE

To the Editor: Vienna is today battling for its very existence. A recent dispatch to the *Musical Courier* says: "Vienna is the saddest city in the world. As one rides through the streets poor mothers with thin, paper-skinned babies look at one from the curb."

A prominent New York banker, recently returned, says: "All that class (professional people) are left with absolutely nothing. All the time I was in Vienna I couldn't help feeling that I was living in a morgue. Beautiful streets, a beautiful opera house and the city beautifully kept—but nothing doing."

Viennese physicians are in desperate straits. Their work must go on at all events, in an effort to combat the increasing mortality and alleviate the many ills of an undernourished population. But they cannot feed their little children with the scanty government ration, even when supplemented with their pitifully meager incomes.

The American Relief Committee for Sufferers in Austria, of which Hon. Frederic C. Penfield, late American Ambassador to Austria-Hungary is honorary chairman, has created a special fund for the relief of destitute Viennese physicians and surgeons.

Contributions may be made to Alvin W. Krech, President, Equitable Trust Company, 37 Wall Street, New York City, Treasurer of the Committee.

AMERICAN COLLEGE OF SURGEONS

STATE AND PROVINCIAL CLINICAL SECTIONS

Montana, Idaho, Oregon, Washington, and Pennsylvania Hold First State Clinical Meetings

DURING September and October, the states of Montana, Idaho, Oregon, Washington, and Pennsylvania held their first sectional clinical meetings and as we go to press most enthusiastic reports are coming in, indicating that the meetings were entirely successful and that no effort will be spared to make them a prominent feature of the Clinical Congress of the American College of Surgeons.

MONTANA

The meeting at Butte, Montana, September 3 and 4, the first sectional clinical meeting to be held, proved beyond a doubt that the state meetings are not only a great satisfaction to those attending them but are an inspiration to the surgeon as well as his guest to do better surgery. Operative clinics were held during the day, and were largely attended. In the evening of September 3, a dinner was given at the Chamber of Commerce at which five hundred people were present. After dinner two hundred more came to hear the program for the meeting open to the public, at which the address of welcome was delivered by the Hon. W. E. Clark, United States Senator from Montana. Talks were given on "The Organization of the American College of Surgeons" by Dr. Franklin H. Martin, secretary-general of the American College of Surgeons; on "The Surgeon in the Community," by Dr. William D. Haggard, professor of surgery, Vanderbilt University, Nashville, Tennessee; on "Standardization of the Hospital" by Mr. John G. Bowman, director, American College of Surgeons; and on "Fitness in Professional Service" by Judge Sidney A. Sanner.

IDAHO

The Idaho section held its first meeting September 6 and 7, at Boise. Clinics were given at St. Alphonsus Hospital by Doctors McCalla, Brandt, Tallman, and Falk. In the evening of September 6, in addition to addresses by Doctors Martin, Besley, and Haggard, Dr. William Howard, of Pocatello, read a paper on "Genito-Urinary Fistulæ." In the evening of September 7, at the meeting open to the public, Dr. E. E. Maxey, chairman, executive committee, gave the address of welcome, Dr. Martin discussed the subject of the organization of the American College of Surgeons, Mr. Bowman the standardization of hospitals, and Dr. Besley gave an address on "How the People of Idaho Could Benefit by the Work of the College."

OREGON

The first annual session of the Oregon section was held in Portland, September 10 and 11. Friday, September 10, was devoted to clinics. In the morning the staffs of St. Vincent's Hospital and the Portland Eye, Ear, Nose, and Throat Hospital entertained the invited guests, and in the afternoon a clinic was given by the staff of the Portland Surgical Hospital. At 8 o'clock in the evening of the same day a large audience assembled in the ballroom of the Multnomah Hotel to hear the addresses at the meeting open to the laity. The Hon. George E. Chamberlain, United States Senator from Oregon, delivered the opening address. Papers were read by Doctors Martin, Besley, Haggard, and Mr. Bowman, and Dr. Ernest F. Tucker, regional director for Oregon, Idaho, and Washington, of the American Society for the Control of Cancer, spoke of the work of that organization. Saturday morning, September 11, was given over to the clinics at the Good Samaritan Hospital and the Portland Eye, Ear, Nose, and Throat Hospital. The program for the afternoon scientific session in the Peacock Room of the Multnomah Hotel included a paper on "Cancer" by Dr. William D. Haggard, of Nashville, Tennessee, and dry clinics by Dr. J. E. Else, Dr. A. W. Baird, Dr. R. Dillehunt, Dr. Ernest Summer, Dr. Andrew Smith, and Dr. Joseph A. Pettit. In the evening at 8 p.m.

at another scientific session in the Rose Ballroom, addresses were delivered on "Organization for Better Surgery" by Dr. Franklin H. Martin, and on "Compound Fractures of the Femur" by Dr. Frederic A. Besley.

Sunday, September 12, was spent in a most delightful all-day trip over the Columbia River Highway.

WASHINGTON

Seattle acted as host for the first annual session of the Washington State Sectional Clinical Congress, which was held September 13, 14, and 15. Monday, September 13, was devoted to registering the invited guests and taking them for drives about the city. In the evening a dinner was given at the Seattle Yacht Club. The morning of September 14 was given over entirely to a discussion of the subject of goiter. At the City Hospital, Dr. John Hunt discussed the anatomy; Dr. Roscoe Mosiman, the pathology; and Dr. J. M. J. Blackford, the diagnosis of goiter.

At 2:30 p.m., September 14, at the meeting open to the public, Park Weed Willis, chairman, executive committee, presided. Besides talks by the speakers who had addressed the sections in Montana, Idaho, and Oregon, Dr. Henry Suzzalo, President of the University of Washington, opened a discussion on the subject of hospital standardization. At. 8:00 p.m. at the scientific session held at the New Washington Hotel, in a symposium on "Gastric and Duodenal Ulcer," Dr. J. F. Griggs, of Tacoma, spoke on the "Diagnosis"; Dr. W. H. Stutsman, of Seattle, on the "Medical Treatment"; and Dr. R. A. McKechnie, of Vancouver, B. C., on the "Surgical Treatment of Gastric and Duodenal Ulcer." Dr. Frederic A. Besley read a paper on "Compound Fractures of the Femur"; and Dr. Franklin H. Martin, on "Organization for Better Surgery."

The morning of Wednesday, September 15, was devoted to bone surgery. From 10:00 to 12:00 a.m. clinics were held at the various hospitals, followed by a general discussion of the day's work on bone surgery.

The afternoon was given over to a discussion of hospital standardization in the state of Washington.

PENNSYLVANIA

The first annual session of the Pennsylvania State Clinical Section was held in Pittsburgh, October 7, 8, and 9, with headquarters at the William Penn Hotel. One hundred and twenty clinicians in thirteen different hospitals participated in an extensive and varied clinical program which filled the morning and early afternoon hours of October 8 and 9. The first scientific meeting was held Thursday evening, October 7, in the Ballroom of the William Penn Hotel. Dr. Edward Martin, chairman of the executive committee, delivered the opening address. Hospital standardization was discussed in addresses by Dr. Franklin H. Martin; Rev. C. B. Moulinier, regent, Marquette University, Milwaukee; Dr. John B. Roberts, Philadelphia; Dr. J. M. Baldy, Philadelphia; and Mr. John G. Bowman, Chicago.

On Friday afternoon at 3 p.m. more than 1,500 people assembled in the ballroom of the William Penn Hotel at the meeting open to the laity and listened to talks by Dr. Franklin H. Martin on "The American College of Surgeons"; Dr. W. L. Estes, of South Bethlehem, Pennsylvania, and Dr. Donald Guthrie, of Sayre, Pennsylvania, on "Conservation of Life and Function from a Surgical Standpoint"; Dr. Charles Davison and Dr. Emil Beck, of Chicago, and Dr. Frank L. Hupp, of Wheeling, West Virginia, on "Prevention of Cancer Mortality"; and Mr. John G. Bowman on "Laymen's Aid in Standardization of Hospitals."

In the evening of Friday, October 8, addresses were delivered by Dr. Chevalier Jackson, of Philadelphia, on "Foreign Bodies in Air Passages and Œsophagus"; Dr. Charles Davison, of Chicago, on "Limitations of Bone Transplantation in Recent Fractures"; and Dr. Emil Beck, of Chicago, on the "Skin-sliding Operation in Chronic Osteomyelitis and Empyema, and Bismuth Paste Treatment."

EXECUTIVE COMMITTEES APPOINTED

In each of the five states in which the first annual session of the State Clinical Sections has been held, executive committees were elected and a place chosen for the next meeting.

Great Falls was agreed upon for the next meeting of the Montana section and the following were chosen as members of the executive committee:

Chairman, Dr. Frederick F. Attix, Lewistown.
Secretary, Dr. James H. Irwin, Great Falls.
Counselor, Rudolph Horsky, Helena.

Pocatello was selected for the next meeting of the Idaho section and the following committee appointed:

Chairman, E. E. Maxey, Boise.
Secretary, E. F. Howard, Pocatello.
Counselor, C. M. Cline, Idaho Falls.

It was unanimously decided that the next annual meeting for the state of Oregon be held in Portland, and the following committee was elected:

Chairman, Andrew Smith, Portland.
Secretary, Joseph A. Pettit, Portland.
Counselor, E. F. Tucker, Portland.

For the state of Washington, Spokane was chosen as the meeting place for the next annual session. The committee chosen includes:

Chairman, Charles F. Eikenbary, Spokane.
Secretary, George C. Bryan, Walla Walla.
Counselor, Charles M. Doland, Spokane.

The time and place for the next Pennsylvania state sectional meeting was not decided upon but was left to the discretion of the executive committee:

Chairman, W. L. Estes, South Bethlehem.
Secretary, Astley P. C. Ashhurst, Philadelphia.
Counselor, J. J. Buchanan, Pittsburgh.

We wish to commend most highly the splendid work that has been done by the executive committees and clinicians in the states in which meetings have been held. With such co-operation and hard work only the greatest success awaits future meetings of the sections.

HOSPITAL LABORATORIES

By WILLIAM S. PETERSEN, M.D., and RICHARD E. SCHMIDT, F.A.I.A., Chicago

DURING recent years, the hospital has materially widened its scope, and today instead of being merely a nursing establishment, it is, in many instances, a center for the study of the medical sciences, promoting research work and the teaching of medicine—a position which the hospital must logically occupy if it is fully to develop its usefulness to the community and to the physician. The great continental hospitals through thorough organization gave to the medical profession the opportunity to advance the study of medicine along scientific lines, and as a result we find the brilliant era of medical and surgical progress which was ushered in with the early eighties. With the impoverishment of Europe, however, medical science turns more and more to America to take up and extend the work already begun. How well we will accomplish the task before us will depend largely on co-operation, equipment, and willingness fully to develop the opportunities before us. This is a responsibility which cannot be ignored. Just as we lead in the physical equipment of the hospital for the care of the patient from the nursing standpoint, so we can lead in developing the clinical sciences and the theory of medicine if we devote only a fraction of the time and the money that has heretofore been used in mere routine, the static function of the hospital.

DEMAND FOR MODERNIZATION OF LABORATORIES

Of the many demands constantly brought before the hospital management, few are so imperative, few so insistently advocated by active attending physicians, as the modernizing of the laboratory unit. Several well-defined causes underlie this demand, all of which have been accentuated during the past five years. Briefly these are as follows: The greater appreciation by the physician himself that the laboratory is a useful and serviceable instrument in diagnosis and the follow-up of treatment. The younger generation of physicians, trained to demand laboratory aid, is gradually making its influence felt in hospital management. Active service in the Army, too, gave many of the older group of physicians the opportunity to study and make use of the more modern clinical laboratory procedures; on their return to civil practice their experience has made them insistent on a modern laboratory service. In other instances the prestige of a modern laboratory in the hospital, the possibility of adding to the hospital income by the fees from a well-conducted laboratory, or the pressure of standardization committees, may be the salient factors. Most important of all, however, is the fact that laboratory work itself and the requisite equipment has taken on a new character and scope. Today a well-equipped biochemical laboratory is an absolute essential, not merely to carry out the former routine urine analysis but to do the blood chemical work, to make proper metabolic studies—basal metabolism—nitrogen and carbohydrate balances,—as well as to correlate the work of the serological, pathological, and bacteriological laboratories.

THE SCOPE OF THE NECESSARY CHANGES

The usual conception of modernization as concerns the laboratory refers to the provision of increased space or the securing of proper equipment. But the mere physical improvement is, of course, inadequate if the proper organization is lacking, and even the organization may prove sterile unless a wholesome spirit of investigation and research pervades the entire personnel. Not that research, in the current conception of the term, should be the chief function of the laboratory of the hospital. By no means. But unless the unusual problems that constantly arise in the hospital be met from an investigative point of view, the work of the laboratory invariably sinks to the level of shop routine.

To function properly three or four separate laboratories should be established: pathology, bacteriology, biochemistry and serology (the latter can with advantage be placed as a subdepartment of any of the first three), and well-trained physicians should be placed in charge. These departments, grouped as a department of laboratories, should be under the direction of a single chief with sufficiently wide training to be able properly to inspire the work of his subordinates. The internes of the hospital should be given a rotating service in the laboratories, primarily to familiarize them with the technique, secondarily to assist in the investigation of extra-routine matters coming to the laboratory. One of the great weaknesses of the American laboratory has been the lack of well-trained technicians

who could take charge of the routine work. It is preposterous to see the amount of petty routine with which the time of many laboratory men is filled. The hospital laboratory has the opportunity to draw its technicians either from the nursing staff, at times even from patients who may find the relatively easy work attractive to them.

The department of laboratories should be organized on a parity with the departments of surgery and of medicine if results are to be expected that are commensurate with the responsibilities. When so organized, co-operation with the clinical departments is facilitated and much reduplication of effort avoided. A centralization of the laboratory group by no means excludes the maintenance of the smaller ward laboratory that is used to advantage for blood work, urinalysis, etc., by the interne on the service.

SPACE ARRANGEMENT

Needless to say the space devoted to the laboratory will depend entirely on the size of the hospital; the funds available for building and maintenance; how much, if any, commercial work is expected; the type of hospital work, etc. A properly grouped arrangement for a larger hospital might with advantage contain the following central group:

Administration. (a) record room; (b) small reception room for patients; (c) directors' laboratory; (d) reading room for staff.

Pathology. In the older period the dismal mortuary in a dark basement, poorly ventilated and without facilities or conveniences of any kind, effectually discouraged postmortem examination, and is in no small measure responsible for the unfortunate state in which this branch of medical science exists today. Given proper ventilation, refrigeration, and lighting, there is no reason why the postmortem table should not be placed in the laboratory itself or in an immediately adjacent room where the material can be properly and promptly studied. A number of hospitals have already adopted this plan with wholly satisfactory results. The refrigerator for the mortuary can economically be so placed that the general refrigerator room for the laboratory group is combined with it. The laboratory refrigerator room should be so arranged that smaller compartments with separate thermostats are provided where various degrees of temperature can be maintained.

Bacteriology. With its adjacent media and incubator rooms the bacteriological laboratory need offer no difficulty in arrangement. Proper lighting should be provided. A laboratory for *serology* may be combined with advantage with the bacteriology room or with the

Biochemical laboratory. Two features should be kept in mind in the planning of this laboratory: (a) Hoods should be provided with ventilators that are efficient, not merely ornamental. Acid digestion methods and other chemical procedures frequently give rise to fumes that are very pungent and irritating and unless proper ventilation is afforded will cause considerable annoyance. (b) Sufficient table space should be provided. The chemical laboratory with its multiplication of glassware and apparatus must be provided with sufficient table space so that apparatus may be left undisturbed during the course of experiments without crowding. A small room for balances between the chemical storeroom and the chemical laboratory will be found very convenient.

Storerooms. A central storeroom for the laboratory group or small storerooms for each laboratory should be provided.

Animal operating room. If investigative work is to be carried on, a small animal operating room with operating table, instruments and sterilizer should be provided. If sufficient room can be spared, a small preparation room should be added.

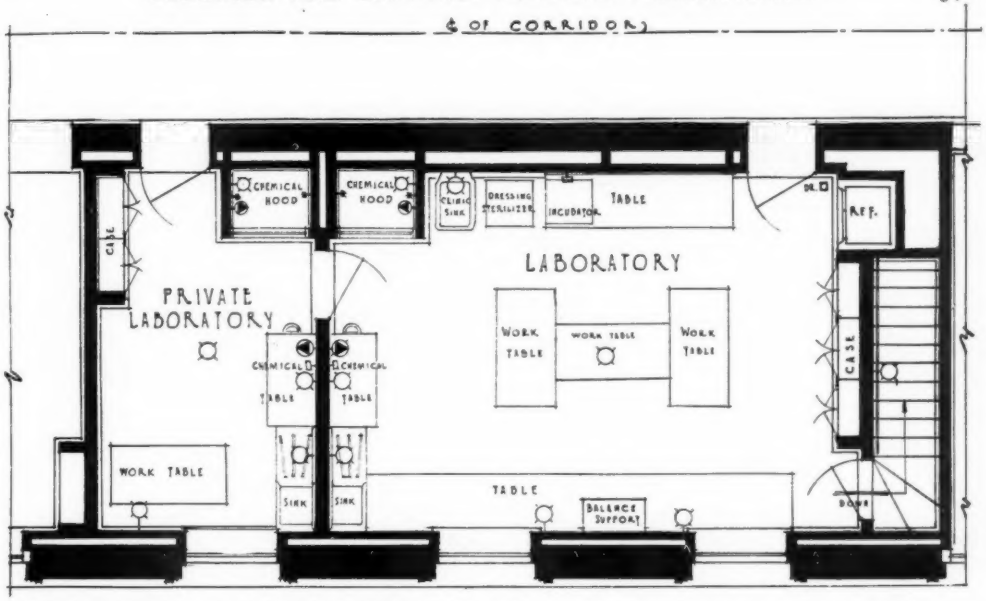
Animal room. A well ventilated animal room should be maintained for the care of smaller animals such as mice, rabbits, and guinea pigs. If feasible sound proofing can be carried out, a limited number of dogs can be kept in metabolism cages in such a room.

Individual research rooms should be provided where space is available.

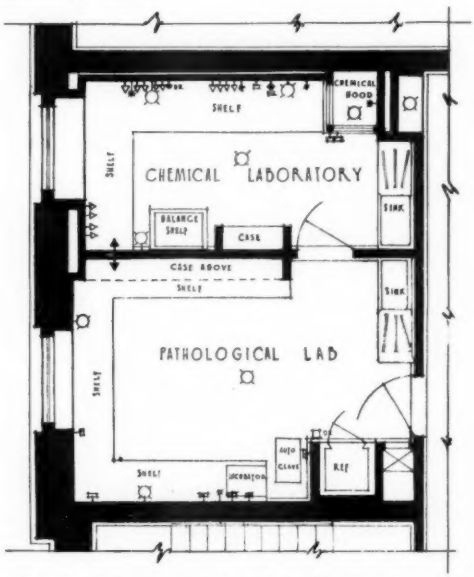
THE EQUIPMENT OF THE LABORATORY

The equipment of the laboratories varies to some extent with the character of the work as well as with the size of the laboratory and the financial support given it. Elaborate equipment by no means guarantees efficient results, but this does not justify the idea that no matter how poor or inadequate the equipment a good laboratory staff can secure the best results.

In the following list no effort is made at completeness—it is merely suggestive of the more important items that make up modern equipment. In some instances we have duplicated apparatus such as microscopes and centrifuges for each laboratory. A considerable saving of time is at times possible when the commoner instruments are duplicated, particularly where much routine work has to be carried out.



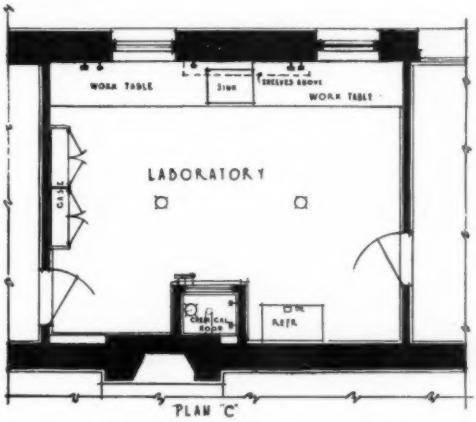
Plan A. Laboratory of the Illinois Central Hospital, Chicago. Note the stairway to basement supply room and autopsy room.



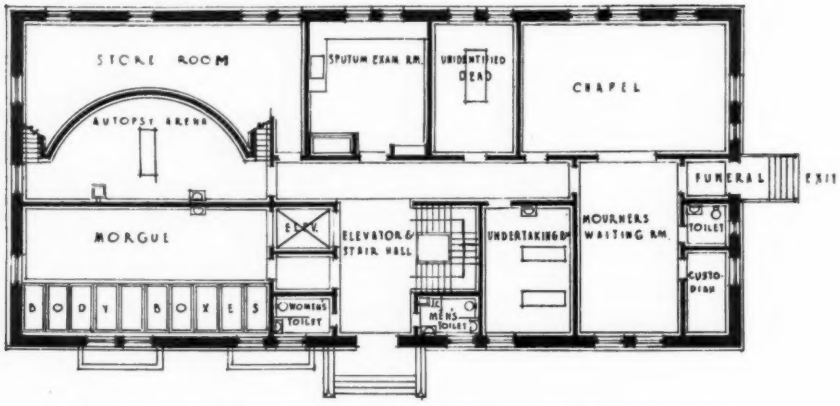
Plan B. Laboratory of the Columbia Hospital, Milwaukee, Wisconsin. The finish of the floors and walls and design of the furniture of the Columbia Hospital, Milwaukee, are similar to those of the Illinois Central Hospital. Note the symbols of various kinds of service outlets connected with Central power plants of these hospitals.

The following symbols apply to all plans:

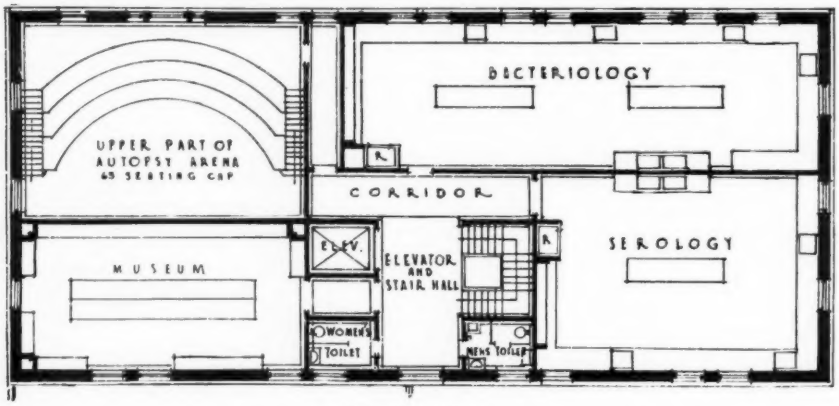
- Ceiling outlet.
- Gas outlet (wall).
- Bracket outlet.
- Wall receptacle outlet.
- Wall power outlet.
- Vacuum outlet.



Plan C. Laboratory of Southern Baptist Sanatorium, El Paso, Texas. (Richard E. Schmidt, Garden & Martin, architects.)



Plan D. Plans for a separate laboratory or wing for a 500-bed hospital made for a public institution. Attention is called to the animal operating rooms, cage rooms, and runway on the roof. Basement plan.

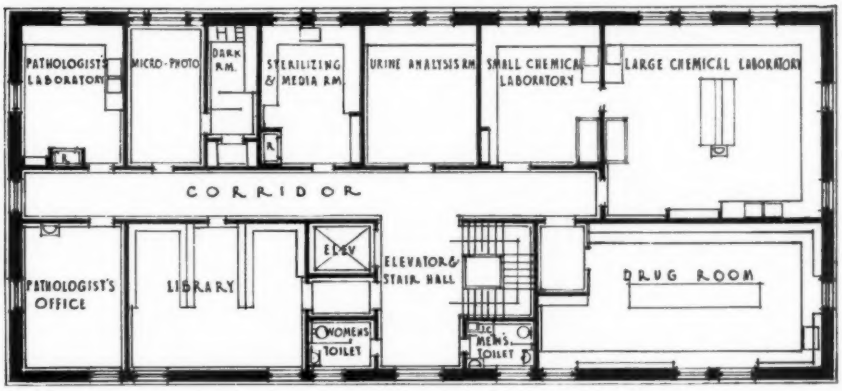


Plan D, first floor.

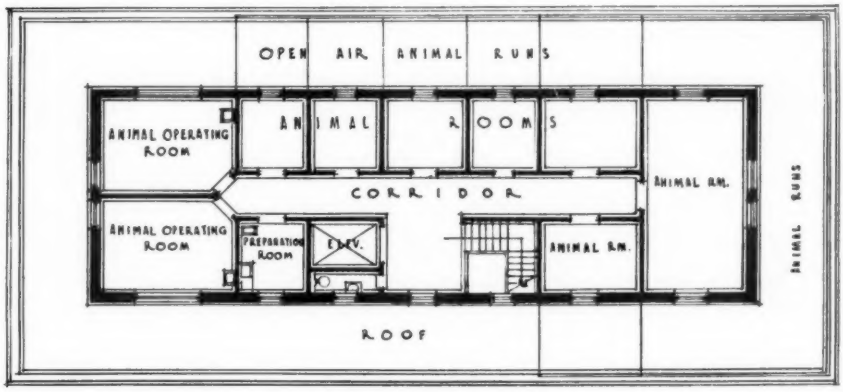
General glassware. Slides and cover glasses; watch glasses; test tubes—hard and soft glass; glass tubing and rods; beakers; flasks; bottles—reagent, stain, aspirator and Woulff bottles; burettes; pipettes; condensers; fermentation tubes; evaporating dishes; crucibles; mortars; graduated cylinders; petri dishes; casseroles; centrifuge tubes; funnels; filtering flasks; Kjeldahl flasks; volumetric flasks; separatory funnels; jars; syringes; thermometers; weighting bottles; distilling flasks; precipitating jars, etc.

General equipment. Triangles; tongs; tripods; wire gauze; burette holders; filter and parchment paper; funnel holders; rubber tubing; rubber and cork stoppers; bunsen burners and attachments; microburners; test tube racks; clamps; blast lamps; cork borers; glass cutter rings; spatulas; brushes; asbestos board; cork board; pinchcocks; supports; drain boards; waste pails; pipette holders; test tube brushers, etc.

Chemistry—clinical pathology and serology. Centrifuges; microscopes; urinometers; albuminometers; hæmocytometers; hæmoglobinometers; polariscope; specific gravity apparatus; water baths (Wassermann, etc.); barometers; calcium chloride cylinders; calcium chloride tubes; balances and weights; basal metabolism apparatus; colorimeter and nephlometer; dissicator; electric stove; hydrometer; Kipp jars; Kjeldahl apparatus; Soxhlet apparatus; vaccine distilling apparatus.



Plan D, second floor.



Plan D, third floor.

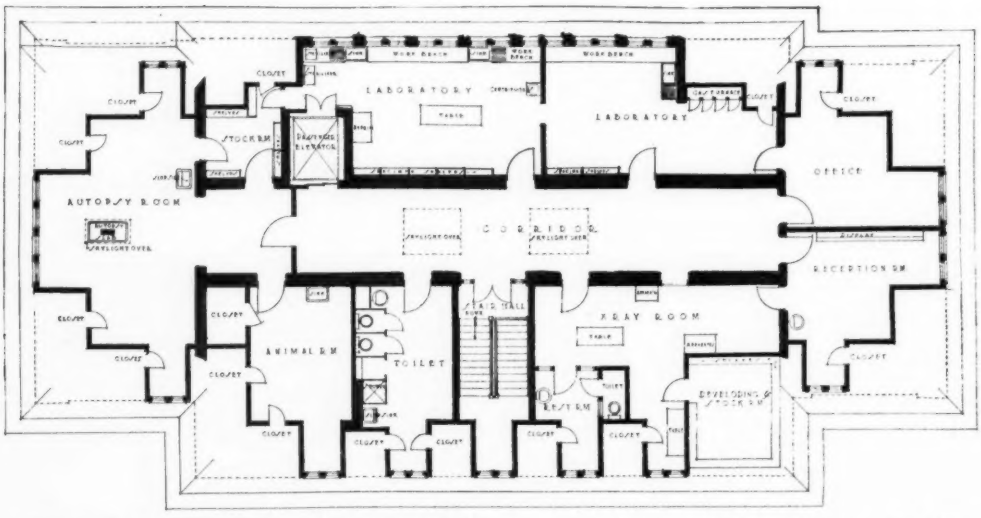
Bacteriology. Centrifuges; microscopes; (dark field, mechanical, stage, warm stage, lamp); water baths; animal cages (mouse jars, etc.); animal boards; sterilizer (autoclave—Arnold—hot air); gas range; balances; shaking apparatus; anaerobic jars; staining dishes; agate mortars; Berkefeld filters; media-apparatus—kettles, funnels, etc.; wire baskets; meat grinders; etc.; ball mill pipette boxes.

Pathology. Centrifuge; microscopes; mechanical stage—lamps; microtomes; parraffin ovens; animal boards; autopsy outfit; freezing apparatus; section lifters; slide boxes; specimen jars.

Additional equipment for research or biochemical laboratory. Microscopes; microphotographic outfit; projecting apparatus; metabolism cages; Van Slyke apparatus; kymograph (signal markers, etc.); combustion furnace; surgical instruments; sterilizer; scale (animal) and weights; stalogmometer; ultramicrometer; press; spectroscope.

LOCATION

The laboratory must be located so that it will be convenient to the staff, and to the various services of the hospital with which it must be constantly in touch, and often very quickly. This is usually a difficult problem and every requirement cannot always be met, so that it is necessary to co-ordinate the location with the more important functions and put up with some arrangements which will mean the least number of inconveniences. Obviously a laboratory should be placed where its staff will be disturbed the least by curious visitors, excessive noise, and other annoyances, and every condition favorable to study and observation should be provided.



Plan E. Laboratory of St. Thomas' Hospital, Nashville, Tennessee. (Asmus and Clark, architects.) The laboratory with X-ray department occupies the entire upper floor. The autopsy room is directly connected to the laboratory.

The plan of a separate adjacent laboratory building has the disadvantage of almost unavoidable isolation from clinical material.

If the work of the laboratory justifies the maintenance of dogs and larger animals, the difficulty of location is increased, inasmuch as the necessity for sound-proofing, ventilation, runways and other outdoor spaces is enhanced. Provisions for such animals can be quite easily made in a separate building at a distance from the hospital which would necessitate less costly construction and extensive mechanical ventilation, but locating an animal building at a distance from the laboratory is fully as disadvantageous as placing the laboratory in a separate building, as pointed out above.

It appears that the laboratory group should, by preference, be placed on the top floor of the hospital. It usually offers the best light, especially if the principal window has a north exposure. The fluctuations of color and intensity of the light will not vary as much as they do from the other points of the compass, and will permit of more accurate and rapid work for which light and color values are important elements; further, north windows do not require shading by window shades or blinds which may darken the laboratory too much or affect the color of the light.

In selecting a location, it must be remembered that the tint or color of light will be affected if reflected from neighboring walls or vegetation.

Grouped in a separate wing on the upper floor, the laboratory is still near enough to the clinical material, but out of the way of clinical routine.

The placing of the laboratory on the ground floor is permissible when only a smaller laboratory is maintained or where a certain amount of extramural commercial work is done, or the floor space is so occupied that no other place can be obtained.

A laboratory should be separated from other services, and its corridor should not be a passageway for other services of the hospital, if a postmortem or mortuary room cannot be made a part of the laboratory or located immediately adjacent to it, the elevator or stairway connection should be made as direct and convenient as possible.

Good planning or arrangement of rooms in their proper sequence for convenience of the staff and for their circulation without disturbance must be sought.

FURNITURE

Wood is generally used for work benches, high tables, cabinets, and other furniture. It is more desirable than metal, marble, or soapstone, although the latter is an excellent material for sinks, tops, bookshelves, and also for the bases of gas stoves. Oak, ash, chestnut, and birch are excellent moderate priced materials for the fronts, which should be finished with a filler, if the

Fig. 1. Illinois Central Hospital, Chicago. (Richard E. Schmidt, Garden & Martin, architects.) The laboratory is in the first story midway between central entrance and the left hand end.

grain is open, shellacked and varnished to show the grain.

On account of its hardness, maple is the best material for the top; white wood is softer but takes a stain with more facility.

The design of the furniture should be as plain as possible to require the least amount of labor to keep it clean. Moldings, recessed panels, and unnecessary ledges to gather dust should be omitted. Flush panel or veneered doors conform to this class of work.

It is a good plan to build bases or pedestals of impervious materials for all of the furniture. These bases should be of the same height and material as the base, or mop-board of the room. The core of concealed portion should be made of cement concrete. Washing and scrubbing soon destroys varnish, and impervious bases such as these resist scrubbing and marring by footwear.

It is rare that two persons agree on the proper height for a work bench. It seems necessary to select an average height and equip the laboratory with revolving top stools. There is a gain in steadiness to the hand and eye if both feet of the worker can rest on the floor and not on the rungs of a stool.

Projecting cupboards and counters, 2 or 3 inches beyond the bases, adds much to the comfort of the worker while standing close to them.

Inasmuch as the best heating results can be obtained by placing radiators under the windows and as work benches must also be placed in these positions, a special arrangement is required to prevent heated air from welling out from under the work benches against the worker. This consists of arranging an opening in the top of the bench adjacent to the window, over the radiator, and attaching a metal apron to the underside of the counter in front of the radiator, and extending downward within 10 or 12 inches of the floor. Obviously the apron must be arranged for easy removal to facilitate cleaning the radiator and the space around it. The opening in the top of the counter should be surrounded by a low standing edge, too low to cast a shadow but high enough to prevent articles from falling into the radiator.

The counter and all other woodwork tops should be built up of 1¾ by 3-inch hard maple strips doweled together with ¼-inch rods from front to back, countersunk at the front for the reception of washers, nuts, and plugging. Wood seems to be the most desirable material for tops for less glassware is broken than if soapstone or other hard material is used. Inasmuch as untreated wood is stained and charred by chemicals, the best finish is a treatment which will blacken it. An excellent recipe for obtaining this end is the following:

Fig. 2. Laboratory of Illinois Central Hospital, Chicago. (Richard E. Schmidt, Garden & Martin, architects.) This laboratory has terrazzo flooring and mop-boards, reinforced concrete balance shelf, walls plastered and enameled. Notice extension leaves and hinged brackets of central high table.

Solution No. 1

Aniline chloride (commercial).....100 grams.
Sal ammoniac.....40 grams
Dissolved in water .....650 cubic centimeters

Solution No. 2

Copper sulphate.....100 grams
Potassium chlorate..... 50 grams
Dissolved in water ..... 650 cubic centimeters

Solution No. 1 should be applied with a brush and allowed to dry thoroughly and sand-papered before Solution No. 2 is applied. After the latter is dry a heavy coat of pure linseed oil will make it an ebony black.

Natural or cork-colored battleship linoleum is quite satisfactory for tops. It does not stain as much as green or dark red, but it does not have the wearing quality of properly treated wood and will sometimes wrinkle or buckle and make the setting up of small articles difficult.

Under each cock of the clinical tables and hoods, there should be a small lead basin made of 6 pounds lead molded into a wood form. The basin, or a series of them, should be connected to lead-lined iron pipe discharging into and above a half round porcelain or earthenware basin at the end of the table. This basin should be trapped and connected to the waste pipes and drains. Such an arrangement will satisfy the sanitary requirements and make it possible to keep the counter drain-pipe clean and easily to recover any object inadvertently dropped into the small lead basins.

A stable platform for a balance can be provided by building a reinforced concrete shelf as a bracket of the masonry walls, as shown on the left of the picture of one of the rooms of the Illinois Central Hospital Laboratory.

The supports of open counters may be of wood, but iron pipes with flanges at the top and the feet doweled into the floor will present a better appearance for a longer time.

Sliding doors in cupboards are convenient and do not obstruct passageways, but they are not as dustproof as hinged doors.

Soapstone appears to be the best material for the chemical hoods. It is impervious, easily worked to form tight joints and to form sloping tops; the sliding sash should, however, be made of wood held in place by wood stops and balanced by cords and counter-weights or spring balances.

Specimen cabinets should be recessed sufficiently deep into the walls to make their fronts and doors flush with the walls and the mop-boards. Dust-gathering projecting tops will be obviated if

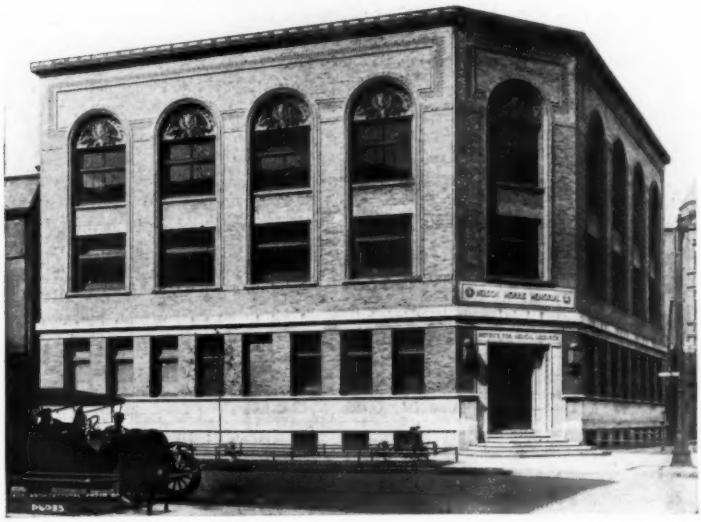


Fig. 3. Nelson Morris Institute for Medical Research, Chicago. (Richard E. Schmidt, Garden & Martin, architects.) The building appears to have only three stories. The fourth story, containing animal operating rooms, small animal cages, and animal runways, is screened by the high decorated wall above the third story windows.

this arrangement is used; otherwise tops sloping at an angle of 45 degrees or more should be built. Walls are not always thick enough for deep recesses but the faces of walls and partitions can be advanced or thickened by the use of furring tile.

Specimen cabinets which pass through a wall with doors on both sides are very useful. Hospital attendants can deliver specimens to the laboratory or call for reports without disturbing the staff during working hours, or in the night or hours when there is no one in the laboratory. The doors on the corridor side and laboratory side are numbered or labeled to correspond with the several stations or services of the hospital.

Small animal cages should be portable and made of metal. Large cages should be hinged together so that they can be readily taken apart for cleaning. These cages should be equipped with rollers or casters so that they can be rolled out from the wall and examined and cleaned on all sides.

The floors and walls around the cages should be made of impervious material and floor drains provided to permit thorough and frequent flushing.

WALLS

The walls should be wainscoted about 5½ or 6 feet high with large tile or salt glazed split brick to remain permanently in a good condition and require a minimum of labor cost for maintenance. Paint and plaster are affected by water and acids, deteriorate quite rapidly and require constant patching and painting.

FLOORS

A resilient flooring material, which will not stain is desirable; battleship linoleum, mastic and asphaltum floors have that quality, but, the first is easily stained, the second is affected by certain oils and greases, and the third is impossible to maintain in a presentable condition, at least to continue to have a good clean appearance.

Now and then an attendant insists on a soft floor, claiming that it is too tiresome to work on a hard floor, but many of the best laboratories have artificial marble or terrazzo floors, which are hard, but which are not easily stained or damaged, and are low priced. Vitrified tile stains the least and affords the best appearance. Cork mats can be provided for use in places where much standing is required.

MISCELLANEOUS EQUIPMENT

Ventilated closets for the storage of articles which may have an offensive odor are a convenience. Mechanical ventilation should be provided for hoods and if the fans are of sufficient capacity it is better to ventilate the laboratories through the hoods than to provide separate exhaust outlets which might cause a back draft and draw obnoxious fumes and odors across the laboratory. Small-sized fans with the exposed parts coated with lead, to prevent corrosion, can be obtained, and it is probably better to arrange each hood as a separate unit, inasmuch as all of the hoods will not be in use at the same time, than it is to install one large fan, which would have to be in constant operation to ventilate at times only a small portion of the laboratory.

The ventilating pipes from hoods should be built of salt glazed earthenware sewer pipes; sheet iron or galvanized iron would be rapidly destroyed by corrosion.

Inasmuch as the lime or cement mortar in the multitude of joints of a brick shaft are quite easily broken down by laboratory fumes, earthenware pipes which have comparatively few joints are more durable.

Bell and spigot earthenware pipes are more easily erected than plain pipes and several thicknesses of burlap about 2 inches wide should be bound around the spigot end of each pipe and brushed with liquefied asphalt. The burlap should be wound for such a thickness that force will be required to push the spigot into the hub, after which the remainder of the hub will be filled with liquefied asphalt and wiped out clean on the inside.

Electric current, fuel gas, steam, brine refrigeration, compressed air, vacuum, hot, cold, distilled and high pressure water are required for the complete laboratory. If these are obtainable from central plant the entire installation will be simplified.

Iron and brass pipes are quickly destroyed by laboratory waste; only earthenware and lead or lead-lined iron pipes should be used for waste piping. Ordinary lead pipe sags and will not remain straight. Lead-lined iron pipe is, therefore, more satisfactory. It should be used in connection with lead-lined fittings to provide a continuous lead conduit. The house drain from the street sewer to the bases of the vertical waste pipes should be of salt glazed earthenware and the latter of lead-lined iron pipe.

The steam pressure for an autoclave should have a pressure of about 50 pounds and high pressure water of about the same. The cocks for water, gas, and vacuum outlets should be ground cocks with nipples for hose connections, and steam valves should be high grade disc type valves. It will be a convenience to provide a liberal number of electric plugs on the work benches and high tables, also in the chemical hoods.

Many further details are required for a builder's specification, which would obviously make an article such as this too technical, but the principles set forth will afford a safe point of beginning for the designer.